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JOHN B. ROBERTS.

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Helen Bingham Roberts,

WHO HAS PERSONALLY
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EARLIEST SCHOOL-DAYS TO THE
PRESENT TIME,

THIS LITTLE VOLUME
IS
AFFECTIONATELY INSCRIBED
BY
HER SON.

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PREFACE.

THE COMPEND OF ANATOMY makes no pretensions to being a treatise on Anatomy, but is a concise statement of what is deemed essential to the student in following the lectures of myself, or other teachers of Human Anatomy. It will also be of use to those working in the dissecting room, or preparing for examinations. As a rule, I have accepted the statements and general arrangement of Gray, in order that it may be used in connection with his most valuable work; but frequent reference has also been made to other anatomical authorities, such as Holden, Heath, and Flower; and some of the descriptions have been taken from the structures themselves. My own students will recognize in the presentation of many subjects much that is familiar to them in my annual courses of lectures at the Philadelphia School of Anatomy, since I have adopted the method that experience there has shown to be most convenient to me, and most beneficial to them. The necessary conciseness has prevented long descriptions, and indulgence is asked, if unimportant details seem, to some, to be passed over with too great rapidity. As a rule, Latin terms have been substituted by the appropriate English names; though in some cases the Latin termination or word has been retained, because a translation or change in termination would so alter the appearance of the word that the student might fail to recognize the identity. In other cases the old name has become anglicized, and is, therefore, retained with descriptive English adjectives; as for example, the greater posterior *rectus* muscle of the head. This is easier recollected by many than its equivalent, rectus capitis posticus major. My thanks are due to Dr. H. Augustus Wilson and Mr. Henry E. Everett, for assistance in certain parts of the work.

J. B. R.

1118 Arch Street, Philadelphia.

THE COMPEND OF ANATOMY.

CHAPTER I.

THE BONES.

USES.—To give support, leverage, protection to organs.

STRUCTURE.—Compact or ivory-like, and cancellated or spongy. The former is usually upon the surface, the latter in the interior. Under the microscope we see Haversian canals for passage of vessels; from these radiate the canaliculi. Around the canals the lacunæ are arranged in lamellæ; it is supposed that each lacuna contains a nucleated cell. Larger spaces exist, in addition to the Haversian canals, called Haversian spaces, and are for supplying the bone with blood elements. Bones are covered by a fibrous membrane called the periosteum, and, if they have a medullary canal, have a somewhat similar lining membrane, denominated the internal periosteum or medullary membrane. The canal in the interior of long bones, and some of the larger Haversian canals contain marrow. Marrow is of two kinds, red, found especially in young bones, and yellow, found particularly in long adult bones. The latter is in composition principally fat. Bones receive blood supply by means of arteries and veins, which enter and make their exit by minute openings over the surface, by large apertures at the ends of bones and by the nutrient canal.

COMPOSITION.—Gelatin and other organic material one-third; calcium salts and other inorganic matter two-thirds.

DEVELOPMENT.—Intra-cartilaginous as in long bones; intra-membranous as in bones of skull.

NUMBER OF BONES in the skeleton varies with age of individual, because various segments coalesce, as for example the sacrum and coccyx, as age increases. In the adult there are 200, if the hyoid and the two patellæ are included.

Spinal column	26
Head	
Cranium	8
Face	14
Sternum and Ribs	25
Hyoid	1
Upper extremities	64
Lower extremities	62
Total	200

The teeth are not bones; the ossicles of the ear and the sesamoid bones are not counted.

VARIETIES.—1, long, as humerus; 2, short, as carpal bones; 3, flat, as occipital and ribs; 4, irregular, as vertebræ and sphenoid.

THE SPINAL COLUMN.

The spine is composed of 24 true and 9 false vertebræ; the latter forming the sacrum, composed of 5 segments, and the coccyx, formed of four segments. A vertebra is composed of a body, and laminæ projecting backwards, to form the vertebral canal for the spinal cord, and uniting at the spinous process. The laminæ are attached to the body by the pedicle; and upon the laminæ are found two transverse and four articular processes. Above and below the pedicles are the intervertebral notches for the exit of the spinal nerves. The true vertebræ are divided into regions as follows: 7 cervical, 12 dorsal and 5 lumbar. The skull also is composed of modified vertebræ.

The cervical vertebræ are distinguished by lateral lips on upper surface of body, anterior lip on lower surface, bifid transverse process with foramen for vertebral artery, vein and nerves, and bifid spinous process. The first cervical, or atlas, is peculiar because it has no body, no spinous process and is composed of two half arches and lateral masses; the second, or axis, is peculiar because of odontoid process, which passes up between the two lateral masses of the atlas to form a pivot upon which atlas and skull rotate. The odontoid process is really the body of the atlas soldered upon the top of the body of the axis. The seventh cervical has a long spinous process which is not bifid.

The dorsal vertebræ are distinguished by half facets on body for heads of ribs, and whole facets on transverse processes for tubercles of ribs. Spinous processes are long and overlap each other. Peculiar dorsal are the first with a whole facet above and a half facet below on the body, the tenth with a whole facet, the eleventh with a whole facet on body but none on transverse process, the twelfth with a whole facet on body and none on transverse process, and inferior articular processes resembling lumbar vertebræ.

The lumbar vertebræ have large oval bodies, long transverse processes, and strong square-looking spines. The fifth lumbar is peculiar because of short transverse process and obliquity of lower surface of body.

DEVELOPMENT OF VERTEBRÆ.—By three primary centres, one for the body and one for each lamina. There are also secondary centres, and some variations in the ossification of the peculiar vertebræ.

THE SACRUM is a triangular bone with base towards lumbar vertebræ and apex towards coccyx. Observe following points: on anterior surface, horizontal ridges showing union of the five false vertebræ, the anterior sacral foramina, the lateral masses due to the coalescing of the transverse processes, the promontory, and the alæ; on posterior surface, the rudimentary spines, the articulating processes, the posterior sacral foramina, the rudimentary transverse processes, the spinal canal, and the cornu on each side for articulation with the coccyx; on the lateral surface, the auricular surface for articulation with ilium; on the base, the articular surface for the last lumbar vertebræ, and the sacral canal; at the apex the facet for the coccyx.

Developed by union of five vertebræ, and has 35 ossific centres. Articulates with fifth lumbar vertebra, two innominate bones and coccyx. Principal muscles attached to it are Pyriformis, Coccygeus, Gluteus Maximus, Latissimus Dorsi, and Erector Spinæ.

PECULIARITIES OF FEMALE SACRUM.—It is wider, less curved from above downwards, and inclines more obliquely backwards than the male.

THE COCCYX is formed of four rudimentary vertebræ. Observe the cornu and the rudimentary transverse process on each side. Developed by four centres, one for each segment. The principal muscles attached are the Coccygeus, Gluteus Maximus, Sphincter Ani and Levator Ani.

THE SKULL.

Composed of Cranium, 8 bones	Occipital. Two Parietal. Frontal. Two Temporal. Sphenoid. Ethmoid.
Face, 14 bones	Two Nasal. Two Superior Maxillary. Two Lachrymal. Two Malar. Two Palate. Two Inferior Turbinated. Vomer. Inferior Maxillary.
Total...............22 bones.	

The cranial bones consist of an outer and an inner table of compact tissue, between which is situated cancellous structure, called in this region diploë.

Occipital.—External surface presents external protuberance, crest, superior and inferior curved lines; condyles; foramen magnum for cord and membranes, vertebral arteries and spinal accessory nerves; tubercles for check ligaments; the basilar process and pharyngeal spine; jugular processes; anterior condyloid foramina for hypoglossal nerves; and occasionally posterior condyloid foramen for a small vein to lateral sinus. Internal surface shows fossæ for cerebrum and cerebellum; internal protuberance; grooves for torcular Herophili, superior longitudinal, lateral and occipital sinuses; ridges for falx cerebri, falx cerebelli and tentorium cerebelli; internal openings of foramen magnum and anterior condyloid foramina; jugular fossa in front of jugular process, on the latter of which is seen the groove for the end of the lateral sinus, and sometimes the orifice of the posterior condyloid foramen. On the basilar process in front of the foramen magnum is a smooth surface upon which lies the medulla oblongata. The occipital, from its superior to its lateral angles, articulates with the parietal, forming the lambdoidal suture; from the lateral to the inferior angle with the temporal; while the basilar process, representing the inferior angle, unites with the body of the sphenoid;

the condyles articulate with the atlas. The bone has four centres of ossification, for posterior, basilar, and each condyloid portion. It gives attachment to the following muscles: Occipito-frontal, Trapezius, and Sterno-mastoid to superior curved line; the Complexus, Splenius-capitis and Superior Oblique to the space between the curved lines; Greater and Lesser Posterior Rectus muscles behind the foramen magnum; the Greater and Lesser Anterior Rectus muscles in front of this opening, the Lateral Rectus muscles at the sides of this same foramen on the jugular processes; and the Superior Constrictor of the Pharynx to the pharyngeal spine.

PARIETAL.—On the external surface the following points are to be examined; the parietal foramen, the parietal eminence, and the temporal ridge for the attachment of the temporal fascia. The inner surface is grooved at its upper border by the superior longitudinal sinus, at the lower posterior angle by the lateral sinus, and at the lower anterior angle by the middle meningeal artery. Near the groove for the longitudinal sinus are seen the depressions for the Pacchionian bodies. The superior border articulates with the bone of the opposite side, forming the sagittal suture; the anterior border with the frontal bone, constituting part of the coronal suture; the posterior border with the occipital, and the inferior border with the sphenoid anteriorly and the temporal throughout the rest of its extent. It is developed from one centre. The Temporal muscle is the only one attached to the parietal bone.

FRONTAL.—It consists of a vertical portion and a horizontal portion. The vertical portion presents upon its external surface the remains of the frontal suture, the frontal eminence, superciliary ridge, supra-orbital arch, supra-orbital notch or foramen, external and internal angular processes, nasal eminence, nasal notch and spine, and beginning of the temporal ridge. On the internal surface of the vertical portion are seen the groove for the superior longitudinal sinus, with the ridges for the falx cerebri; the frontal crest; and the foramen cæcum, which is sometimes incomplete. There are spaces between the two plates of the vertical portion, called frontal sinuses, communicating with the anterior ethmoid cells and middle meatus of the nose by means of the infundibulum on each side. The horizontal portion consists of the thin orbital plates, separated by the ethmoidal notch; these orbital plates show on their lower aspect the fossa for the lachrymal gland, and the point of attachment of the pulley for the Superior Oblique muscle. The edges of the ethmoidal notch present several half cells, completed when the ethmoid bone is articulated with the frontal, and two grooves, similarly completed, called the anterior and posterior ethmoidal canals. The internal surface of the orbital plates has no important landmarks upon it. The frontal articulates with the parietal, sphenoid, ethmoid, nasal, superior maxillary, lachrymal and malar. The muscles attached to it are the Corrugator Supercilii, Orbicularis Palpebrarum, and Temporal. It is developed by two ossific centres.

TEMPORAL.—It consists of three parts, squamous, mastoid, and petrous. The squamous on its outer surface presents the zygomatic process extending forward to articulate with the malar bone; at the base of this process are seen the tubercle, and the articular eminence; behind it the glenoid fossa for articulation with the condyle of the lower jaw bone and for the parotid gland, the Glaserian fissure for the passage of the Laxator Tympani muscle, and the vaginal process. In the angle between the squamous and petrous portions, and parallel to this fissure, can be seen the canal of Huguier for the chorda tympani nerve. The inner surface of the squamous portion is grooved by the middle meningeal artery. The mastoid portion contains in its interior cells, and presents on its external aspect the mastoid foramen, digastric fossa and occipital groove; and on the internal, a deep groove for the lateral sinus. The petrous portion has a pyramidal form, and hence presents a base, an apex, three surfaces and three borders. It contains the organ of hearing. The base and apex are each perforated by a large opening, the former by the external auditory meatus, surrounded by the auditory process of bone, the latter by the internal or cerebral opening of the carotid canal. On the posterior surface of the petrous portion there are two important points to be remembered, on the anterior three, and on the inferior four.

Posterior.—Internal auditory meatus, for facial and auditory nerves.
Aqueduct of the vestibule, for small vessels.

Anterior.—Elevation over superior semicircular canal.
Hiatus Fallopii, for greater petrosal nerve.

Depression for Casserian ganglion of trifacial nerve.
Inferior.—Lower opening of carotid canal.
Jugular fossa.
Styloid process, for three muscles and two ligaments.
Styloid-mastoid foramen, for facial nerve.

There are four less important points on the inferior surface: 1, the aqueduct of the cochlea; 2, the canal for Jacobson's nerve (tympanic branch of glosso-pharyngeal), lying between the carotid canal and the jugular fossa; 3, the canal for Arnold's nerve (auricular branch of pneumogastric), lying in the jugular fossa; and 4, the auricular fissure, between the vaginal and mastoid processes, for the exit of this same Arnold's nerve.

The anterior border of the petrous bone is unimportant; the superior is grooved for the superior petrosal sinus, the inferior, at its inner part, for the inferior petrosal sinus. The tentorium cerebelli is attached to the upper border in the reëntrant angle. Between the petrous and squamous portions are the orifices of two canals leading into the tympanum; one for the Eustachian tube, and above it that for the passage of the Tensor Tympani muscle. They are separated by the cochleariform process. The aqueduct of Fallopius is the canal between the internal meatus and the stylo-mastoid foramen.

The temporal bone is developed by four centres, for the squamous, the petrous and mastoid, the styloid, and auditory processes respectively. It articulates with the occipital, parietal, sphenoid, malar and inferior maxillary. The principal muscles attached to it are—

Squamous	Temporal, Masseter.
Mastoid	Occipito-frontal, Sterno-mastoid, Trachelo-mastoid, Splenius-capitis, Digastric.
Styloid Process...	Stylo-pharyngeus, Stylo-hyoid, Stylo-glossus.
Petrous............	Elevator of Palate, Tensor of Tympanum.

SPHENOID.—This bone resembles a bat with outstretched wings. It presents for consideration a body, two large and two small wings, and the pterygoid processes (legs of the bat). The superior surface of the bone shows in front the ethmoidal spine, projecting from the front of the lesser wings, with grooves for the olfactory nerves on each side; immediately behind is the optic groove leading to the optic foramina; then the olivary process, behind which is the sella Turcica for the petuitary body. On each side of the sella Turcica are seen the three clinoid processes, while posteriorly are situated the surface supporting the medulla oblongata, and the articular surface for the basilar process of the occipital bone. Along each side of the body of the sphenoid lies the groove for the cavernous sinus, and between the two wings the sphenoidal fissure, or anterior lacerated foramen, is situated. At the root of the greater wing are seen two openings, the round foramen running forward for the superior maxillary division, and the oval foramen downward for inferior maxillary division, of the fifth nerve. The spinous process, perforated by the spinous foramen, projects backward from the great wing.

The antero-inferior surface of the bone presents the vertical lamella and rostrum for articulation with the ethmoid and vomer, and the openings of the sphenoid sinus partially covered by the sphenoidal turbinated processes. On the inner side of the base of the pterygoid process is seen a small aperture called the pterygo-palatine canal, and still nearer the median line of the body of the bone the vaginal process, articulating with the edge of the vomer. Perforating the base of the pterygoid process is the Vidian canal, and above it externally the anterior opening of the round foramen.

The pterygoid process consists of an internal and external plate with the pterygoid notch between. The internal terminates in the hook, or hamular process, for the tendon of the Tensor Palati muscle. The scaphoid fossa lies at the base of the internal plate on its posterior aspect. The greater wing has three surfaces, the cerebral, the orbital, and the external, divided by the pterygoid ridge into two parts. The upper portion of this surface has the Temporal, and the lower the External Pterygoid muscle attached. The lesser wing is a thin plate, fitting into the fissure of Sylvius of the brain, and forming the upper boundary of the anterior lacerated foramen.

The sphenoid is developed from ten ossific centres: for lesser wings, 2; for greater wings, 2; for internal pterygoid plates, 2; for body, 2; for sphenoidal turbinated plates, 2. It articulates with occipital, parietal, frontal, temporal, ethmoid, malar, palate and vomer. The muscles attached are the Temporal, External and Internal Pterygoid, the muscles of the orbit except the Inferior Oblique, Superior Constrictor of the pharynx, Tensor Palati and Laxator Tympani.

Ethmoid.—The organ of smell is contained in this bone, which resembles the letter T, with a lateral mass hanging from each half of the horizontal portion of the letter. The horizontal plate of the bone lies between the orbital plates of the frontal; and is perforated with holes for the branches of the olfactory nerve, and for the exit of the nasal branch of the ophthalmic nerve, which has entered the cranial cavity, from the orbit, by the anterior ethmoidal foramen. The horizontal plate is called the sieve-like or cribriform plate. Projecting upwards is the crista galli for the attachment of the falx cerebri. The perpendicular, or vertical plate, of the bone forms a portion of the septum between the nasal cavities. The lateral masses, consisting of numerous cells and half cells, form part of the inner wall of the orbit, and of the outer wall of the nasal cavities. The surface of the lateral masses presenting towards the orbit is smooth,and is designated the os planum; the surface towards the nose shows two scroll-shaped processes called the superior and middle turbinated bones, or processes, of the ethmoid. From the lower edge of the os planum projects the unciform process, to assist in closing the antrum of the superior maxilla. In the anterior part of the lateral mass of each side is a canal called the infundibulum, leading from the anterior ethmoid and frontal sinuses to the middle meatus of the nose. This bone is formed from three centres, one for each lateral mass and one for the vertical plate. It articulates with the frontal, sphenoid, nasal, superior maxillary, lachrymal, palate, inferior turbinated, vomer, and also with the triangular cartilage of the nose. No muscles are attached to it.

THE FACE.

Nasal.—There is nothing of special importance about this bone, except the crest on its internal surface at the inner edge, and the groove on this same surface for the nasal nerve. It is developed from one centre, and articulates with the frontal, ethmoid, superior maxillary and opposite nasal. No muscles are attached to it.

Superior Maxillary.—The body of this bone is made hollow by the maxillary sinus, or antrum of Highmore, which opens into the middle meatus of the nose. It supports four processes; the malar, nasal, alveolar for the sockets of the upper teeth, and the palatine or roof of the mouth. It enters into the formation of the orbit, the nose and the mouth. The anterior, or facial surface, presents the incisive and canine fossæ, separated by the canine eminence, the infra-orbital foramen, and a part of the lower margin of the orbit. The posterior surface is marked by the posterior dental canals, the maxillary tuberosity and half of the posterior palatine canal. The orbital, or superior surface, forms part of the floor of the orbit, and is grooved by the infra-orbital canal. The internal, or nasal surface, shows, above the palate process, the opening of the antrum, half the lachrymal duct, the inferior turbinated crest for the inferior turbinated bone, and above this, on the nasal process, the superior turbinated crest for the middle turbinated bone. Below the crests lie the inferior and middle meatuses of the nose. The antrum has its orifice much diminished, when the bones are articulated, by the ethmoid, inferior turbinated and palate bones. The malar process joins the maxillary process of the malar bone; the nasal process ascends alongside of the nasal bone, and is grooved by half of the lachrymal duct. The alveolar process has eight cavities for the two incisor, one canine, two bicuspid, and three molar teeth. The palate process constitutes a great portion of the roof of the mouth, and of the floor of the nose; it is perforated by the anterior palatine canal, and in front projects to form the anterior nasal spine. The bone is developed by four centres; facial, orbital and malar, palate, and incisive. It articulates with frontal, ethmoid, nasal, malar, lachrymal, inferior turbinated, palate, vomer and the other superior maxillary. The muscles of importance attached to it are, Orbicularis Palpebrarum, Elevator of the Upper Lip, Elevator of the Lip and Nose, Elevator of the Angle of Mouth, Masseter, Buccinator, and Orbicularis Oris.

LACHRYMAL.—This shows the lachrymal groove for the lachrymal sac, is developed by a single centre, and articulates with frontal, ethmoid, superior maxillary and inferior turbinated. The Tensor Tarsi has its origin from this bone.

MALAR.—The cheek bone has frontal, zygomatic, maxillary and orbital processes, and is perforated by the temporo-malar canals. It is formed from one ossific centre, and articulates with frontal, sphenoid, temporal and superior maxillary. The muscular attachments are Elevator of the upper Lip, Greater and Lesser Zygomatics, Masseter and Temporal.

PALATE.—This bone is shaped like the letter L, having a vertical and a horizontal plate. The horizontal plate forms the back part of the hard palate, and therefore serves as the floor of the nose in the posterior part of that cavity. Its anterior edge articulates with the palate process of the upper jaw bone, its internal with the opposite palate bone, its external joins the vertical plate, while the posterior is free for the attachment of the soft or muscular palate. In the middle line the two plates unite to form the posterior nasal spine. The vertical plate, on its nasal surface, presents the inferior and superior turbinated crests for the inferior and middle turbinated bones, resembling in this respect the inner surface of the superior maxilla. Below these crests are seen the inferior and middle meatuses of the nose. The anterior part of this plate is prolonged as the maxillary process, which covers part of the opening of the antrum; at the back part is seen the posterior palatine canal. At the junction of the two plates posteriorly is situated the tuberosity, or the pterygoid process, of the palate, which fits into the notch between the two pterygoid plates of the sphenoid. The middle portion of the vertical plate presents the sphenoidal process, at the base of which is the spheno-palatine foramen separating it from the orbital process above. This consists of a five-sided process containing a cavity or sinus in its interior. The surfaces are named maxillary, sphenoidal, and ethmoidal, because they articulate with these bones; and orbital and zygomatic, because looking toward these cavities. The palate is formed from one centre, and articulates with sphenoid, ethmoid, superior maxillary, inferior turbinated, vomer and opposite palate. The Azygos Uvulæ, Tensor Palati, Internal and External Pterygoid and Superior Constrictor of the pharynx are attached to it.

INFERIOR TURBINATED.—This facial bone lies within the nasal fossa, and is scroll-shaped, or curled. It has a lachrymal, a maxillary and an ethmoid process, and is developed by a single centre of ossification, and articulates with the lachrymal, superior maxillary, ethmoid and palate. It is covered by the nasal mucous membrane.

VOMER.—The bony septum of the nose is formed to a great extent by this bone, which has been called the plough-share or vomer. Its base has two alæ, or wings, which articulate upon the sides of the rostrum of the sphenoid; along each side of the bone is a groove or canal for the naso-palatine nerve. The articulations are with the sphenoid, ethmoid, two superior maxillary and two palate bones, and with the triangular cartilage of the nose.

INFERIOR MAXILLARY.—The lower jaw bone is really two bones united at the chin, and hence each half is symmetrical. It carries the lower teeth which correspond in name and number with those of the upper jaw, formed of the two superior maxillary bones. The inferior maxilla is composed of the body, or horizontal horse-shoe shaped portion, and a perpendicular portion, or ramus, on each side. The body presents in front the mental process and the symphysis; and laterally the incisive fossa, the mental foramen, the external oblique line and the groove for the facial artery. On the inner surface of the body are seen the genial tubercles, fossa for the sublingual gland, depression for Digastric muscle, internal oblique line, or mylo-hyoid ridge, and fossa for submaxillary gland. The alveolar border of the body contains the sockets for the teeth.

In the child there are on each side, 2 incisors, 1 canine, 3 molars; in the adult, 2 incisors, 1 canine, 2 bicuspids and 3 molars. The ramus, or vertical portion has at its upper border the condyloid process, for articulation with the glenoid cavity of the temporal bone, the coronoid process, for the attachment of the Temporal muscle, and the sigmoid notch between. On its internal aspect are seen the aperture of the inferior dental canal, the mylo-hyoid groove for the vessels and nerve of that name, and the spine for the internal lateral ligament of the temporo-maxillary joint. The angle of the jaw to which the stylo-maxillary ligament is fastened, is made by the junction of the ramus and body. The lower jaw is developed by two lateral ossific centres, and articulates on each side with the temporal bone.

Many muscles of the lips and of mastication are fastened to this bone.

Lips............	Elevator and Depressor of Lower Lip, Depressor of Angle of Mouth, Platysma Myoid, Orbicularis Oris.

Mastication...Buccinator,
Masseter,
Internal and External Pterygoid,
Temporal,
Digastric,
Genio-hyoid,
Mylo-hyoid.
Geni-hyo-glossus.

Certain changes in the shape of the lower jaw occur during the various periods of life. These are due to the fact that when the full number of permanent teeth are in position the alveolar process must be deep, to support them firmly. Hence, in infancy and old age, the mental foramen is near the upper edge of the body, because there is no marked alveolar process. In the same way, the angle made by the axis of the ramus and the axis of the body is obtuse, because the jaws are not separated by the teeth. In adult life the alveolar process is high in both jaws, and the bone shows nearly a right angle between body and ramus.

SUTURES.

The lines of articulation of the bones of the head are called sutures, which are named from the bones forming them. Thus the junction of the parietal and temporal bones constitutes the parieto-temporal suture. Certain important sutures have received specific names which must be remembered.

The Sagittal Suture is the Inter-parietal.
" Coronal " " Fronto-parietal.
" Lambdoidal " " Occipito-parietal.
" Basilar " " Occipito-sphenoidal.
" Transverse " " Fronto-facial.

The transverse extends across the upper part of the face and the orbit, being the articulation of the frontal with the malar, sphenoid, ethmoid, lachrymal, superior maxillary and nasal bones.

The existence of these sutures must be remembered in examining the skull in suspected fracture.

FONTANELLES.

The fontanelles are openings in the infant's skull situated between the angles of the parietal and the adjacent cranial bones. They are occupied with unossified membrane, which soon after birth becomes bony. There are six such openings, two in the median line, called anterior and posterior, and two lateral ones on each side. The fontanelles are important in obstetric practice.

WORMIAN BONES.

Spaces in the cranium, which remain unossified by the ordinary ossific centres, have at times special bony centres developed, which then form small irregular bones. These, from their three-cornered shape, are often called ossa triquetra. The term Wormian bone is generally preferred.

FORAMINA OR OPENINGS OF THE SKULL.

Foramen Cœcum	Vein.
Cribriform Openings	Olfactory and nasal nerves.
Anterior Ethmoid	Anterior ethmoid vessels, nasal nerve.
Posterior Ethmoid	Posterior ethmoid vessels.
Optic	Optic nerve, ophthalmic artery.
Anterior Lacerated, or Sphenoidal Fissure	Third, fourth, ophthalmic division of fifth, and sixth nerves; ophthalmic vein.
Round	Superior maxillary division of fifth nerve.
Oval	Inferior maxillary division of fifth nerve, small meningeal artery and small petrosal nerve.
Spinous	Middle meningeal artery.
Of Vesalius	Vein.
Middle Lacerated	Filled with fibro-cartilage; Vidian nerve crosses it above.
Carotid	Internal carotid artery, carotid plexus of the sympathetic nerve.
Hiatus of Fallopius	Great petrosal nerve.
Internal Auditory Meatus	Facial and auditory nerves, auditory artery.
Aqueduct of Vestibule	Small artery and vein.
Posterior Lacerated or Jugular	Glosso-pharyngeal, pneumogastric and spinal accessory nerves in front; internal jugular vein, meningeal branches of occipital and ascending pharyngeal arteries behind.

Anterior Condyloid	Hypoglossal nerve.
Posterior Condyloid	Vein.
Great (Foramen Magnum)	Medulla oblongata and membranes, both spinal accessory nerves, both vertebral arteries.
Mastoid	Vein and artery.
Anterior Palatine	Anterior palatine vessels, naso-palatine nerves.
Posterior Palatine	Posterior palatine vessels and palatine nerves.
Pterygo-Palatine	Pterygo-palatine vessels.
Eustachian	Eustachian tube.
Of Tensor Tympani	Tensor Tympani muscle.
Vidian	Vidian nerve.
Glaserian Fissure	Laxator Tympani muscle, tympanic artery, processus gracilis of malleus.
Canal of Huguier	Chorda tympani nerve.
Jacobson's	Tympanic branch of glosso-pharyngeal nerve.
Arnold's	Auricular branch of pneumogastric nerve.
Aqueduct of Cochlea	Vein.
Stylo-Mastoid	Facial nerve, stylo-mastoid artery.
Aqueduct of Fallopius	Facial nerve.
Supra-orbital	Supra-orbital artery, vein and nerve.
Infra-orbital	Infra-orbital artery and nerve.
Mental	Mental artery and nerve.

FISSURES.

Sphenoidal Fissure	Same as anterior lacerated foramen.
Spheno-maxillary	In back of orbit between great sphenoid wing and superior maxillary bone. Transmits superior maxillary nerve, infra-orbital artery, ascending nerves from Meckel's (spheno-palatine) ganglion.
Pterygo-maxillary	Between pterygoid process of sphenoid and superior maxilla. Is at right angles to the spheno-maxillary. Transmits branches of internal maxillary artery.

FOSSÆ.

Anterior	Lodges the frontal lobes of cerebrum.
Middle	Lodges the temporo-sphenoidal lobes of cerebrum.
Posterior	Lodges the cerebellum, pons Varolii and medulla oblongata.
Temporal	From temporal ridge to pterygoid ridge, inside of zygomatic arch.
Zygomatic	Below zygoma and pterygoid ridge, between ramus of lower jaw and pterygoid process of sphenoid.
Spheno-maxillary	Triangular space beneath apex of orbit, at junction of spheno-maxillary and pterygo-maxillary fissures. Contains the spheno-palatine ganglion (Meckel's).
Orbit	Pyramidal cavity, the walls of which are made by frontal, sphenoid, ethmoid, superior maxilla, malar, lachrymal and palate. Contains eye, with its muscles, vessels, nerves, etc.
Nasal Fossæ	One on each side of middle line, and separated by the septum. Open on face by anterior nares (or nostrils), into pharynx by posterior nares. Formed by frontal, sphenoid, ethmoid, and all the bones of face except malar and lower jaw.
	Septum formed principally by vertical plate of ethmoid, and the vomer.
	On outer wall find three passages or meatuses under the turbinated bones.
Superior Meatus	Under superior turbinated (process of ethmoid).
	Into it open sphenoid and posterior ethmoid cells and spheno-palatine foramen.

Middle Meatus..........	Under middle turbinated (process of ethmoid). Into it open frontal and anterior ethmoid cells by infundibulum, and antrum.
Inferior Meatus.........	Under inferior turbinated. Into it opens nasal duct.

HYOID, OR LINGUAL BONE.

This bone is shaped like a horse-shoe, and has a body with a greater and a lesser cornu, or horn, on each side. It supports the base of the tongue, and is developed by five centres, one for the body, and one for each horn. The principal muscles attached are as follows:

Sterno-	Hyoid	Genio-Hyo-Glossus.
Thyro-		Hyo-Glossus.
Omo-		Middle Constrictor of Pharynx.
Stylo-		Tendon of Digastric.
Mylo-		
Genio-		

The following ligaments are inserted into it: stylo-hyoid, thyro-hyoid, and hyo-epiglottic.

THORAX.

The chest cavity, or thorax, contains the heart and lungs, and is formed by the dorsal vertebræ, the ribs, with their cartilages, and the sternum.

STERNUM.—It consists of three segments; the manubrium or handle, the gladiolus or sword, and the ensiform or xiphoid appendix. The manubrium, or upper piece, presents a facet on each side for the clavicle, one for the first costal cartilage, and a half facet for the second costal cartilage. On its upper border is the interclavicular notch. The second segment is marked by transverse lines, showing that it is developed by different ossific centres, and on its lateral borders are seen facets for the cartilages of the ribs. There are four complete facets on each side, and a half one at the upper and lower angles. These facets are situated at the lines of junction of the various bony centres, similar to the costo-vertebral articulations. The ensiform appendix is the thin semi-cartilaginous lower extremity of the sternum, and has a half facet at its base for the seventh costal cartilage. There is, sometimes, a foramen in the lower part of the sternum. It is developed by six primary centres, one for the manubrium, one for the ensiform appendix, and four for the central segment. Occasionally, there are pairs of ossific centres for one or more segments, and then a foramen may exist by imperfect coalescing of these bony nuclei. Articulates with clavicles and seven costal cartilages. Muscles attached are, Sterno-mastoid, Sterno-hyoid, Sterno-thyroid, Greater Pectoral, Triangularis Sterni, Diaphragm, and aponeurosis of Abdominal muscles.

Ribs.—There are twelve on each side. The seven upper ones are true ribs, while the remaining five are called false. The seven connected with the sternum by their own cartilages are denominated vertebro-sternal ribs; the three (8th, 9th, 10th), attached to the sternum indirectly by means of their own cartilages articulating with the cartilages of those above, are called vertebro-costal (or vertebro-chondral); the last two are floating, or vertebral ribs. A rib has a shaft, or body, and two extremities. The posterior, or vertebral end, consists of a head, neck, and tuberosity. Observe the double facet on the head, for articulation with two adjacent vertebræ, and the ridge for the inter-articular ligament. The tuberosity presents a surface for articulation with the transverse process of the vertebra. The shaft has an angle, and a groove on the inside of the lower border, for the intercostal artery and nerve. The anterior extremity is hollowed out to receive the cartilage.

Peculiar Ribs.

First, . .	short, flat, no angle, single facet on head, tubercle separating two grooves for subclavian vessels.
Second, .	angle close to tuberosity, shaft not twisted.
Tenth, . .	single facet on head.
Eleventh,	single facet; no tuberosity.
Twelfth, .	single facet; no tuberosity; no angle.

The ribs are developed from three centres; head, shaft tubercle. Those that have no tubercle are ossified from two centres. The muscles attached to the ribs and cartilages are numerous:

Pectorals (Greater and Lesser).
Intercostals (External and Internal).
Scalenes (Anterior, Middle and Posterior).
Serratus (Great, Posterior Superior, Posterior Inferior).
Abdominal Muscles.
Dorsal Muscles (Latissimus Dorsi; Sacro-lumbalis, etc).

UPPER EXTREMITY.

CLAVICLE, OR COLLAR BONE.—The sternal end is cuboidal, and presents articular surfaces for sternum, and for first costal cartilage, and rough depression on lower surface for attachment of costo-clavicular (rhomboid) ligament. The outer, or acromial end is flattened, and is marked by facet for the articulation, and a tuberosity and oblique line on inferior aspect for coraco-clavicular (conoid and trapezoid) ligament. The shaft is curved, and on the lower surface has a groove for the Subclavius muscle. It is developed by a centre for the shaft, and one for the sternal end. The most important muscular attachments are: to inner half, Greater Pectoral and Sterno-cleido-mastoid; to outer half, Deltoid and Trapezius; and underneath, Subclavius.

SCAPULA.—This bone has an anterior surface, or venter; a posterior surface, or dorsum; a superior border or costa; an external, or axillary border; an internal, or vertebral border; a superior angle, an inferior angle, an external angle, or head; and two processes. The venter is almost entirely occupied by the subscapular fossa; the dorsum is divided by the spine into the supra-spinous and infra-spinous fossæ. The spine begins at the vertebral costa, or border, by a smooth triangular surface, and terminates in the acromion process. The acromion projects over the shoulder-joint, and has a facet for the clavicle. The superior border of the scapula terminates, at the outer end, in the coracoid process, and has near the root of this process the supra-scapular notch for the passage of the supra-scapular nerve. The artery of this name passes above the transverse ligament, crossing the top of this notch. The external border is wide, for muscular origins, and above its middle is grooved for the dorsal artery of the scapula. The internal border, or base of the bone, is thin, and has numerous muscles attached to it. The superior and inferior angles have muscular attachments, and are unimportant. The external angle, or head of the bone, presents the glenoid cavity, or socket, for the head of the humerus; and shows a constriction behind, called the neck.

The scapula is developed by seven centres; one for body, two for coracoid process, two for acromion, one for posterior border, and one for inferior angle. The humerus and clavicle articulate with it. The muscular attachments are important, and may be stated as follows:—

Venter	Subscapular.
Dorsum	Supra-spinous, Infra-spinous.
Spine	Deltoid, Trapezius.
Superior Border	Omo-hyoid.
Posterior Border.	Great Serratus, Elevator of Angle of Scapula, Greater and Lesser Rhomboid.
External Border.	Triceps, Greater and Lesser Teres, Biceps,
Coracoid	Biceps, Coraco-brachial, Lesser Pectoral.
Acromion	Platysma.

HUMERUS.—The upper extremity consists of a head, neck, and two tuberosities. The head is hemispherical, and articulates with the glenoid cavity of the scapula; around it is a constriction called the anatomical neck, separating the head from the tuberosities. Below the tuberosities is situated what has been called the surgical neck, though there is at that point no marked constriction. The greater tuberosity presents three facets for the insertions of the Supra-spinous, Infra-spinous, and Lesser Teres muscles; the lesser has one facet for the Subscapular muscle. Between the tuberosities is the bicipital groove, bounded by the anterior and posterior bicipital ridges, and lodging the tendon of the long head of the Biceps and a branch of the anterior circumflex artery. The shaft presents on its posterior surface the musculo-spiral groove, for the musculo-spiral nerve and the superior profunda artery; near its middle is seen, on the outside, the rough surface for the insertion of the Deltoid, on the inner side, that for the Coraco-brachial muscle. Near the latter is the nutrient foramen for the passage of the nutrient vessels. The lower extremity is flattened antero-posteriorly, and presents the articular surface for the bones of the forearm. This is divided into the trochlear surface for the ulna, and the radial head of the humerus, so-called, for the radius; above these surfaces, in front, are two depressions, into which the upper parts of these bones fit during extreme flexion, and which are called respectively the coronoid and the radial depressions. Behind, there is a single fossa, called the olecranon depression. At the sides of the articular surface are two tubercles, called condyles, of which the inner is the more prominent; from these a ridge runs upwards on each side of the shaft, called the supra-condyloid ridge.

The humerus is developed by seven centres, one each for shaft, head, greater tuberosity, radial head, trochlear surface, internal and external condyle; and articulates with scapula, radius and ulna.

Muscular Attachments.

Greater Tuberosity....	Supra-spinous, Infra-spinous, Lesser Teres.
Lesser Tuberosity......	Subscapular.
Shaft.......................	Greater Pectoral, Latissimus Dorsi. Greater Teres, Deltoid, Coraco-brachial. Anterior Brachial, Triceps.
Internal Condyle........	Ulnar Flexor of Wrist, Radial Flexor of Wrist. Superficial Flexor of Fingers. Round Pronator of Radius, Long Palmar.
External Condyle and Ridge..................	Extensors and Supinators, viz.: Ulnar Extensor of Wrist. Long Radial Extensor of Wrist. Short Radial Extensor of Wrist. Common Extensor of Fingers. Extensor of Little Finger. Long Supinator. Short Supinator and Anconeus.

ULNA.—The upper extremity consists of two processes, a large posterior one called the olecranon, and a smaller one anteriorly, named the coronoid process. Between these is the greater sigmoid cavity for articulation with the humerus, and to the outside of them the lesser sigmoid cavity for the head of the radius. The shaft is prismatic, and tapers toward the lower extremity, which consists of the head of the ulna and the styloid process. The head has, on its lateral surface, a facet for the radius; on its inferior aspect, an articular surface for the triangular cartilage, which separates the bone from the wrist-joint. The ulna is developed from a centre for the shaft, one for the olecranon and a third for the lower end. It articulates with the humerus and radius, but has no direct osseous articulation with the wrist bones. The attached muscles are important.

Olecranon	Triceps, Anconeus, Ulnar Flexor of Wrist.
Coronoid	Anterior Brachial, Round Pronator of Radius. Superficial and Deep Flexors of Fingers. Long Flexor of Thumb.
Shaft	Deep Flexor of Fingers, Square Pronator. Ulnar Flexor of Wrist, Ulnar Extensor of Wrist. Anconeus, Short Supinator. Extensors of Thumb (3). Extensor of Index.

Radius.—The upper end consists of a head, neck, and tuberosity. The head has a shallow cup which articulates with the radial head of the humerus, and a smooth circular border that rotates in the lesser sigmoid cavity of the ulna. The shaft terminates below in a large extremity, which has a sigmoid cavity for the ulna, and a large concave surface for articulating with the carpus to form the wrist joint. The scaphoid and semilunar bones are the only carpal bones that articulate with the radius. The lower extremity of the radius has a styloid process, though it is not as prominent as that of the ulna. The lower end of the radius is grooved, on its posterior and external surface, for the tendons of the extensors; all of which pass over it, except the Ulnar extensor of the wrist, which has a groove for itself in the lower end of the ulna. The radius has a centre of ossification for the shaft, and one for each extremity, and articulates with the humerus, ulna, scaphoid and semilunar. The muscular attachments are as follows:

Tuberosity	Biceps.
Styloid Process	Long Supinator.
Shaft	Short Supinator, Superficial flexor of fingers. Long flexor of thumb, Square Pronator. Extensor of metacarpal of thumb. Extensor of first phalanx of thumb. Round Pronator of radius.

Hand.—The hand is composed of the carpus of eight bones, the metacarpus of five, and the fourteen phalanges. The carpal bones are arranged in two rows of four each. Their names, from the radial towards the ulnar side, are—

First Row.—Scaphoid, semilunar, cuneiform, pisiform.
Second Row.—Trapezium, trapezoid, magnum, unciform.

The important points to remember about them are, that only the first two mentioned enter into the formation of the articulation with the forearm, and that the pisiform is very prominent at the base of the hand on the ulnar side, and may be mistaken for a tumor by the careless student. The metacarpal bones are five in number, one for each finger, and have a cuboidal base, a shaft and flattened head. They differ somewhat from each other, in regard to size and the existence of lateral articular facets at the base. The most important peculiarity is that the metacarpal of the thumb, in shape and in method of ossification, resembles a phalanx. There are fourteen phalanges, if the metacarpal of the thumb be still considered a metacarpal; otherwise, we count four metacarpals and fifteen phalanges. A phalanx has a base, a shaft, and a head composed of two small condyles, separated by a groove. The last, or ungual, phalanges have a rough oval surface for the support of the pulp of the finger tips.

The carpal bones are developed from a single centre for each; the metacarpals by two centres, one for the shaft and one for the head; the phalanges by two centres, one for the shaft and the other for the base. The metacarpal of the thumb, however, is developed like a phalanx. The following muscular insertions are important:—

Radial flexor of wrist, to base of metacarpal of index.
Ulnar flexor of wrist, to base of metacarpal of little finger.
Radial extensor of wrist (longer), to base of metacarpal of index.
Radial extensor of wrist (shorter), to base of metacarpal of middle finger.
Ulnar extensor of wrist, to base of metacarpal of little finger.

INNOMINATE BONE—OS INNOMINATUM.—This bone in youth exists as three separate pieces, which at about the age of puberty unite to form one irregular bone. The three segments are called the ilium, ischium, and pubes; and it is usually more convenient to describe each of these separately than to attempt to take the innominate as a whole.

THE ILIUM is the broad portion that forms the prominence of the hip, or haunch. The external surface, or dorsum, is crossed by the superior, middle, and inferior curved lines, which, starting at the great sacro-sciatic notch behind, radiate

PUBES	External and Internal Oblique, Transversalis, Rectus, Pyramidalis, Small Psoas, Pectineus, Long and Short Adductors, Gracilis, External and Internal Obturators, Levator Ani, Compressor of Urethra.

THE PELVIS.

The pelvis is formed by the two innominate bones, the sacrum and the coccyx. The ilio-pectineal line divides the pelvis into the true and false pelvis. The upper, or false, is a large basin-like cavity between the iliac bones; the lower, or true pelvis, has a cavity, an inlet or superior strait, and an outlet or inferior strait. When the trunk is erect the pelvis is placed obliquely, so that the axis of the superior strait is upwards and forwards. The female pelvis is less massive than the male, the iliac bones are further apart, the cavity is larger, the pubic arch wider, and the sacrum usually wider and less curved.

The great sacro-sciatic foramen, formed by the notch of the same name, and the lesser sacro-sciatic ligament, transmits the Pyriformis muscle, the gluteal vessels and nerves, the sciatic vessels and nerves, and the internal pudic vessels and nerves. The lesser sacro-sciatic foramen, completed by both sciatic ligaments, transmits the Internal obturator muscle and allows the internal pudic vessels and nerves to reënter the pelvis.

FEMUR.—The upper end presents the head, neck, and greater and lesser trochanters; which trochanters are connected by the anterior and posterior inter-trochanteric lines. The anterior inter-trochanteric line is sometimes called the spiral line. Behind and below the top of the greater trochanter is seen the digital fossa, while at the junction of its lower portion with the neck of the bone in front is seen the tubercle of the femur. The posterior inter-trochanteric line is marked, and has a rough ridge running downward from it, which is called the line for the quadrate muscle. The head of the bone has a small fossa for the round ligament. The lower extremity is divided into two large knobs, or condyles, separated by the inter-condyloid notch behind, and by the trochlear surface for the patella in front. Both condyles are smooth on the lower surface, for articulation with the tibia, but the inner condyle is rather longer than the outer. The outer condyle presents on its external surface a tuberosity, and a depression and groove for the tendon of the Popliteus muscle; while on the inner condyle is seen the inner tuberosity and a tubercle for the insertion of the Great adductor. The shaft is smooth anteriorly; but on its posterior surface is seen the linea aspera, a rough ridge which bifurcates above and below. The upper lines into which it divides continue to the trochanters, the inner one running around in front of the lesser trochanter to join the anterior inter-trochanteric line. The lower ridges extend down to the condyles, leaving between them a triangular interval called the popliteal space, or ham. On the posterior surface of the femur above the condyles are the depressions from which the two heads of the Gastrocnemius arise.

The femur articulates with the innominate bone, tibia and patella, and is developed by a centre for each of the following parts, making in all five—shaft, head, lower extremity, greater trochanter and lesser trochanter. The muscles attached to it are important.

Great Trochanter......	Middle and Small Gluteals, Pyriformis. Internal and External Obturators, Quadratus Femoris. Superior and Inferior Gemellus.
Small Trochanter......	Great Psoas, Iliac (just below it).
Shaft......................	Internal and External Vast, Great Gluteal, Biceps (short head), Pectineus, Long, Short and Great Adductors, Crureus, Subcrureus.
Condyles..................	Gastrocnemius, Plantaris, Popliteus.

PATELLA.—This is a large sesamoid bone developed in the tendon of the Four-headed extensor muscle of the leg. It is somewhat triangular in shape, and presents on its lower surface two facets for articulation with the condyles of the femur. The outer facet is the larger. The lower portion, or apex of the bone, has attached to it the ligament of the patella. The bone has one centre of ossification, which does not appear until after birth. It articulates with the femur, and has attached to its upper and lateral surface the four components of the Four-headed extensor, viz., Rectus Crureus, External Vast and Internal Vast.

TIBIA.—The upper end, or head, is composed of the two tuberosities, external and internal, which have the upper articular surface smooth, to form with the condyles of the femur the knee-joint. Between the articular surfaces is located the spine, with depressions in front and behind, for the attachments of the crucial ligaments and semi-lunar cartilages. Below the tuberosities in front is the tubercle, to which is attached the ligament of the patella, having between itself and the upper part of the tubercle a bursa. The posterior border of the inner tuberosity has a groove for the tendinous insertion of the Semi-membranous muscle; that of the outer one a facet for the head of the fibula. The shaft of the bone has three surfaces and three borders. The inner surface is principally subcutaneous, and at the upper part of the posterior surface is the oblique line. The anterior border is called the crest or shin, and the external, or interosseous, border gives attachment to the interosseous membrane. The lower extremity is prolonged on its inner aspect and forms the internal malleolus; on its outer aspect is seen the facet for the lower end of the fibula. The lower surface of the inferior end of the tibia and the external surface of the internal malleolus are smooth, for articulation with the astragalus. Behind this malleolus is a marked groove in which lie the tendons of the Posterior Tibial and Long Flexor of the toes. The tibia is developed by a centre for the shaft and one for each extremity; and articulates with femur, fibula and astragalus.

MUSCLES.

Inner Tuberosity	Semi-membranous.
Outer Tuberosity.......	Anterior Tibial, Long Extensor of Toes.
Shaft	Sartorius, Gracilis, Semi-tendinous, Anterior Tibial, Popliteal, Soleus, Long Flexor of Toes, Posterior Tibial.
Tubercle..................	Four-headed Extensor of Leg (by ligament of patella).

FIBULA.—The head, or upper extremity, has a facet for articulation with tibia, and a styloid process projecting upwards. The lower end constitutes the external malleolus, and has on its inner aspect a smooth articular surface for the astragalus, above which is the surface for the triangular ligament holding it to the tibia. The shaft has three surfaces and three borders; the inner border is better called the interosseous ridge. The oblique line of the fibula begins at the inner side of the head, and at the lower part of the bone becomes continuous with the interosseous ridge. The bone is ossified by three centres, head, shaft, and lower end; and articulates with tibia and astragalus.

MUSCLES.

Head......................	Biceps, Soleus, Long Peroneal.
Shaft......................	Long Extensor of Toes, Extensor of Great Toe, Soleus, Posterior Tibial, Long Flexor of Great Toe, Long Peroneal, Short Peroneal, Third Peroneal.

FOOT.

The bones of the foot are divided into three regions; tarsus, metatarsus, phalanges.

TARSUS.—The tarsal bones are seven—calcaneum or os calcis, astragalus, cuboid, scaphoid, internal, middle and external cuneiform bones. The os calcis has on its upper surface two articular facets for the astragalus, and a groove for the interosseous ligament; internally is a process called the sustentaculum, which supports the inner part of the astragalus. The inferior surface has two tubercles; the internal surface is concave, allowing space for the passage of tendons and other structures underneath the sustentaculum; and the external has a tubercle for a ligament. To the posterior surface is attached the tendon of Achilles, while the anterior articulates with the cuboid. The astragalus consists of a body, neck and head. The body articulates with tibia and fibula above and laterally, with os calcis underneath, and has a groove behind for the Long flexor of great toe. Anterior to the body is the head, smooth for articulation with the scaphoid, and having behind it the constriction or neck of the bone. The scaphoid is concave behind for the head of the astragalus, and convex in front for articulation with the three cuneiform; it has a tubercle for the Posterior tibial muscle. The cuboid presents nothing particular except the groove for the Long peroneal. The cuneiform are three in number; internal, external and middle. The articulations of these bones are as follows:—

Os Calcis	with	Cuboid, astragalus.
Astragalus	"	Tibia, fibula, os calcis, scaphoid.
Cuboid	"	Os calcis, external cuneiform, fourth and fifth metatarsal.
Scaphoid	"	Astragalus, the three cuneiform.
Internal Cuneiform.	"	Scaphoid, middle cuneiform, first and second metatarsal.
Middle Cuneiform	"	Scaphoid, internal and external cuneiform, second metatarsal.
External Cuneiform	"	Scaphoid, middle cuneiform, cuboid, second, third and fourth metatarsal.

METATARSUS.—These five bones have each a base, shaft and head. The first has at its base a surface for the insertion of the Long peroneal tendon, and at its head two surfaces for two sesamoid bones; the second is remarkable for the manner in which its base is wedged between the external and internal cuneiform bones; and the fifth has a large tubercle at its base.

PHALANGES.—The phalanges resemble those of the hand, and are arranged in a similar manner, two for the great toe and three for each of the others. The ungual phalanges, namely:—the second of the first toe, and the third of the other toes, have the irregular distal extremity for the sensitive pulp.

The tarsal bones are developed by one centre in every instance, except the os calcis, which has an epiphysis, or separate centre, for its posterior extremity. The metatarsal bones, except the first, have a centre for the shaft and one for the digital extremity or head; the phalanges have a centre for the shaft and one for the base. The first metatarsal is ossified like the phalanges, and is really to be considered a phalanx, as is the first metacarpal of the hand.

The principal muscular attachments of the foot are as follows:—

Os Calcis	Gastrocnemius, Soleus, Plantaris, Abductor of great toe, Abductor of little toe, Short extensor of toes, Short flexor of toes, Accessory flexor of toes.
Internal Cuneiform.	Anterior tibial, Posterior tibial.
Metatarsal	Interosseous, Long, Short and Third peroneals, Adductor of great toe, Short flexor of little toe, Anterior tibial.

Phalanges................	Long and Short extensors of toes, Long and Short flexors of toes; Abductor, Adductor, Short flexor, Long flexor, and Extensor of great toe; Short flexor and Abductor of little toe; Interosseous; Transverse of foot.

SESAMOID BONES.—These are little nodules of bone found in tendons, which press very firmly upon the bony surfaces over which they glide. The patella is a large sesamoid bone; others are found in the Short flexor of the great toe, Short flexor of the thumb, etc. They are usually situated over joints, but not necessarily, for some occur where a tendon curves around a bone, as that in the Long peroneal as it lies in the groove of the cuboid.

CHAPTER II.

THE ARTICULATIONS AND LIGAMENTS.

A joint or articulation is a union of two or more bones of the skeleton, and may be immovable, movable, or partly movable. The immovable articulations, of which those of the cranium may be taken as examples, have the bones in close contact, with only a thin layer of cartilage, or fibrous tissue between them. The partly movable joints, such as the inter-vertebral and inter-pubic, are formed by having the bones united by tough and elastic fibro-cartilages; but the movable joints are much more elaborate in construction. The bones are covered by cartilage, and held together by non-elastic ligaments, forming a sort of capsule, which is lined by the synovial membrane, similar to a serous membrane in structure, secreting the synovial fluid to lubricate the structures forming the articulation.

In situations where tendons, or the integument, glide over bony prominences there are developed sacs, similar to the synovial membrane in structure. These are called burses, or bursæ, and are to limit friction.

Many terms have been used to describe the different varieties of articulations, but a large number of them are useless to the student, and may be discarded. The most important are worthy of insertion and description.

Movable Joints. (*Diarthroses.*)	Gliding (arthrodia); as sterno-clavicular.
	Ball and Socket (enarthrosis); as shoulder, hip.
	Hinge (ginglymus); as elbow, ankle.
	Rotatory (lateral ginglymus); as atlo-axoid, head of radius.

LIGAMENTS OF THE TRUNK AND HEAD.

Spinal Column.—*Inter-vertebral substances* between the bodies of true vertebræ; *anterior common ligament* along front of bodies from axis to sacrum; *posterior common* along back of bodies from axis to sacrum. *Yellow elastic* ligaments between the laminæ of the movable vertebræ; *capsular* surrounding the articular processes. *Inter-spinous and supra-*

spinous lying between and over the spinous processes respectively, and *inter-transverse* between the transverse processes.

ATLAS AND AXIS.—*Anterior atlo-axoid* from anterior arch of atlas to body of axis, and really a prolongation of anterior common of spine; *posterior atlo-axoid* from posterior arch of atlas to laminæ of axis. *Transverse*, to keep odontoid process in position, stretches across from tubercles on inner surface of articular processes of atlas. *Capsular* are identical with same ligaments in other regions of the spine.

OCCIPITAL AND ATLAS.—*Anterior occipito-atloid* from basilar process to anterior arch, a sort of continuation of anterior common of spine; *posterior occipito-atloid* from posterior margin of great foramen to posterior arch; *lateral occipito-atloid* from jugular process to transverse process of atlas. *Capsular* as in other regions of spine.

OCCIPITAL AND AXIS.—*Occipito-axoid* from anterior margin of great foramen to back of body of axis. It is really a mere prolongation of the posterior common ligament of spine. The *odontoid* or *check* are three in number, though sometimes only the two lateral are described as check ligaments, and the middle called the suspensory of the odontoid process. The three stretch from the top of the odontoid process to the sides and front of the great foramen.

LOWER JAW.—*External lateral* from tubercle of zygoma to outside of neck of condyle; *internal lateral* from spinous process of sphenoid to inner border of dental foramen; *capsular* from edge of glenoid cavity to neck of condyle. There is also an *inter-articular* fibro-cartilage with a synovial membrane above, and another below it. *Stylo-maxillary* from styloid process of temporal to angle of jaw.

The stylo-hyoid ligament has nothing to do with the jaw, but is in this region, connecting the styloid process and small horn of the hyoid bone.

RIBS AND VERTEBRÆ.—The head of the rib and bodies of the vertebræ are connected by *anterior costo-vertebral* (stellate), consisting of three separate bands going to the body above, the body below, and the inter-vertebral disk between these; by the *inter-articular* ligament, which divides the joint, giving occasion for two synovial sacs, and extends from ridge on head to inter-vertebral cartilage; and finally by a *capsular*.

The rib is attached to the transverse processes by four ligaments; *anterior costo-transverse* from upper edge of neck of rib to transverse process of vertebra above; *middle* *costo-transverse* (interosseous) from posterior surface of neck to transverse process: *posterior costo-transverse* from tubercle to apex of transverse process: and ***capsular***. There are some modifications of these various ligaments depending on the peculiarities of certain ribs and vertebræ; for example, if the rib articulates with but one body there can be no inter-articular ligament, and if the rib has no tubercle there will be no capsular ligament there.

COSTAL CARTILAGES AND STERNUM.—*Anterior costo-sternal* from cartilage to front of sternum: *posterior costo-sternal* from back of cartilage to back of sternum; ***capsular***, surrounding joint and enclosing synovial membrane. There is no synovial membrane at first joint, but there are two at the second, because there exists here an *inter-articular* ligament joining the costal cartilage with the cartilage between manubrium and gladiolus.

The joints between the cartilages of the lower ribs are strengthened by *capsular*, and *external* and *internal intercostal* (interchondral) ligaments. The ribs are joined to the corresponding cartilages by the cartilages fitting into a depression in the end of the ribs and being held by the periosteum.

STERNUM.—The first and second pieces of the sternum are united by *anterior sternal* and *posterior sternal* ligaments, and an intervening layer of cartilage.

PELVIS AND SPINE.

The last lumbar vertebra and the sacrum are connected by the ligaments found in other regions of the spine, viz., *anterior* and *posterior common*, *inter-vertebral* substance, *yellow elastic ligaments*, *inter-spinous*, *supra-spinous* and *capsular*; and also by the *lumbo-sacral* from transverse process of fifth lumbar to lateral mass of sacrum. The *lumbo-iliac* extends from tip of same process to crest of ilium.

PELVIS.—The sacrum and ilium are united by *articular cartilages*, with at times a synovial sac, and *anterior sacro-iliac* and *posterior sacro-iliac* running across the joint in front and behind. The sacrum is connected with the ischium by *great sacro-sciatic* (or posterior) stretched from the posterior inferior spine of ilium, and side of sacrum and coccyx to the tuberosity of ischium, thus completing the small sacro-sciatic notch; and by the *small sacro-sciatic* (or anterior) from side of sacrum and coccyx to spine of ischium, completing the great sacro-sciatic notch. The sacrum and coccyx are joined by an intervening *fibro-cartilage*, and *anterior* and *posterior sacro-coccygeal*. The symphysis of the pubes consists of two articular cartilages with a synovial membrane, and the two pubic bones, held together by *anterior* and *posterior pubic* ligaments, a *superior pubic* and a *sub-pubic*. The first three are horizontal bands of fibres, while the fibres of the sub-pubic have an arched direction, running from one ramus to the other.

UPPER EXTREMITY.

STERNAL END OF CLAVICLE.—The joint between the sternum and clavicle has an *inter-articular fibro-cartilage*, with two synovial membranes, and is united by the following ligaments: *anterior sterno-clavicular*, *posterior sterno-clavicular*, and *inter-clavicular* passing across the top of the sternum from one clavicle to the other. The clavicle is also attached to the thorax by the *costo-clavicular* ligament, often called the rhomboid, which passes from the first costal cartilage to the lower surface of the clavicle.

ACROMIAL END OF CLAVICLE.—There is sometimes an inter-articular fibro-cartilage found between the acromion and clavicle, but it is often absent. The joint is held by a *superior* and an *inferior acromio-clavicular* ligament. This end of the clavicle is fastened to the coracoid process by the *coraco-clavicular* ligament, consisting of two portions often designated conoid and trapezoid.

SCAPULA.—The *coraco-acromial* extends from the side of coracoid process to the tip of acromion, the *transverse* across the supra-scapular notch.

SHOULDER.—*Capsular* from edge of glenoid cavity to anatomical neck of humerus; *coraco-humeral* from coracoid to margins of bicipital groove; and *glenoid*, which is a fibro-cartilaginous band deepening the glenoid cavity. The long tendon of Biceps also acts as a ligament.

ELBOW.—*Anterior* from humerus, above coronoid fossa, to coronoid process of ulna and orbicular ligament; *posterior* from border of olecranon fossa to olecranon process of ulna; *internal lateral* from inner condyle of humerus to edge of coronoid and olecranon processes; *external lateral* from external condyle to orbicular ligament.

RADIUS AND ULNA.—The *orbicular* ligament surrounds the head of the radius, having its ends attached to the borders of the lesser sigmoid cavity. The *oblique* extends from tubercle at base of coronoid process to the radius just below the tubercle at which the biceps is inserted. The *interosseous membrane* is attached to the interosseous ridges of the bones. At the lower part of the forearm there is an *anterior radio-ulnar*, and a *posterior radio-ulnar* extending across the articulation in front and behind, and a *triangular fibro-cartilage* beneath the inferior end of the ulna, attached to the styloid process of ulna and the edge of radius.

WRIST.—*Anterior* from lower ends of radius and ulna in front to first row of carpal bones; *posterior* from lower end of radius behind to first row of carpals; *external lateral* from styloid process of radius to scaphoid; *internal lateral* from styloid process of ulna to pisiform and cuneiform.

CARPUS.—There are *palmar*, *dorsal* and *interosseous* ligaments, holding first row of carpal bones together, and *palmar*, *dorsal* and *interosseous*, holding the second row in position. There are in addition *palmar*, *dorsal* and *lateral* forming the attachment between the two rows. The *external lateral* passes from scaphoid to trapezium, the *internal lateral* from cuneiform to unciform.

The synovial membranes in this vicinity are important. There are five in connection with the bones of the forearm, wrist, and metacarpus. 1, Above the triangular cartilage between radius and ulna; 2, between the forearm above and first row of carpals below; 3, a large sac lying between the first and second row of carpals, and extending down to line the joints between the carpus and metacarpus; 4, a special membrane between the pisiform and cuneiform; 5, a special one between the trapezium and metacarpal of thumb.

CARPUS AND METACARPUS.—The articulation here is accomplished by *palmar*, *dorsal* and *interosseous* ligaments, except in the case of the thumb, where there is only a strong *capsular* ligament.

METACARPUS.—The bases are united by *palmar*, *dorsal* and *interosseous*, the heads by the *transverse* ligament running across the palmar surface.

METACARPUS AND PHALANGES.—These joints are maintained by a *palmar* and two *lateral* ligaments.

PHALANGES.—The various phalanges are held together by *palmar* and *lateral* ligaments. The extensor tendons act as dorsal ligaments for the metacarpo-phalangal, and phalangal articulations.

LOWER EXTREMITY.

HIP.—The ligaments are very strong, as is required by the great range of motion allowed this joint. The *capsular* is attached to margin of acetabulum above, and to neck of the femur below; in front, it is inserted into the inter-trochanteric line of femur, but behind, its attachment is to the middle of neck above inter-trochanteric line. The *ilio-femoral* extends from anterior inferior spine of ilium to anterior inter-trochanteric line, bifurcating and running towards the two trochanters. The *round* ligament (teres), attaches the depression in head of femur to the fossa at bottom of acetabulum. The *cotyloid* ligament is circular, fibro-cartilaginous, and is attached to the edge of the acetabulum, just as the glenoid is in the shoulder joint. The *transverse* ligament crosses the cotyloid notch at the lower part of the acetabulum.

KNEE.—The ligaments of this articulation are divided into the external and internal. The external are as follows:—1, *Anterior* (ligament of patella), from apex of patella to tubercle of tibia; 2, *posterior*, from condyles of femur to head of tibia, being reinforced by an oblique fasciculus from tendon of Semi-membranous muscle; 3, *internal lateral*, from inner condyle to inner side of head of tibia; 4, *long external lateral*, from external condyle to head of fibula; 5, *short external lateral*, from outer condyle to styloid process of fibula; 6, *capsular*, filling up intervals between these ligaments to complete the encasement of the articulating extremities of the bones.

The internal are as follows: *anterior crucial*, from fossa in front of spine of tibia to inner surface of external condyle; *posterior crucial*, from depression behind spine to inner condyle; *internal semi-lunar fibro-cartilage*, attached to tibia in front of the anterior crucial, and in front of the posterior crucial ligament; *external semi-lunar fibro-cartilage*, to tibia in front and behind spine, and is nearly circular. It will, therefore, be seen that the ends of the semi-lunar cartilages, except the anterior extremity of the internal cartilage, are all attached to the tibia between the crucial ligaments. The *transverse* ligament passes between the anterior extremities of the semi-lunar cartilages, while *coronary* ligaments on each side hold the semi-lunar cartilages to the head of the tibia. The *mucous* and *alar ligaments* are really not ligaments, but folds of synovial membrane containing perhaps, a little ligamentous tissue.

The former is attached to the lower part of the patella and to the inter-condyloid notch, while the latter are two fringe-like folds extending from the sides of the former.

TIBIA AND FIBULA.—These bones are united above by an *anterior superior* and a *posterior superior tibio-fibular* ligament passing across the joint from external tuberosity of tibia to head of fibula. One lies in front and the other behind the joint. The shafts of the bones are united by the *interosseous membrane* fastened to the interosseous ridges. The lower extremities are joined by an *interosseous* ligament, lying between the tibia and fibula; by an *anterior inferior tibio-fibular* and a *posterior inferior tibio-fibular*, crossing the front and back of the articulation; and by the *transverse*, which crosses the back of the joint from external malleolus nearly as far as internal malleolus.

ANKLE.—The ligaments of this hinge-joint are: *anterior*, from edge of articular surface of tibia to astragalus; *internal lateral* (deltoid), from inner malleolus to astragalus, os calcis and scaphoid; *external lateral*, consisting of three bands running from outer malleolus to astragalus and os calcis. The anterior and posterior bands go to the astragalus, the middle to the os calcis.

TARSUS—FIRST ROW OF TARSAL BONES.—Os calcis and astragalus by *external calcaneo-astragaloid*, joining outer surfaces; *posterior calcaneo-astragaloid*, connecting posterior portions; and *interosseous*, lying between the bones.

SECOND ROW OF TARSAL BONES.—Scaphoid, cuboid and cuneiform by *dorsal*, *plantar* and *interosseous* ligaments.

TWO ROWS OF TARSAL BONES WITH EACH OTHER.—Os calcis and cuboid. *Superior calcaneo cuboid* on dorsal aspect; *interosseous*, sometimes called internal calcaneo-cuboid, between the two bones; *long plantar* (long calcaneo-cuboid), from in front of tuberosities of os calcis to ridge on plantar surface of cuboid; *short plantar* (short calcaneo-cuboid), lying deeper, from lower surface of os calcis to lower surface of cuboid.

Os calcis and scaphoid. *Superior calcaneo-scaphoid* from os calcis to outer side of scaphoid; *inferior calcaneo-scaphoid* from sustentaculum process of os calcis to scaphoid.

Astragalus and scaphoid. *Superior astragalo-scaphoid* from neck of astragalus to upper surface of scaphoid bone.

Of all these ligaments there are two which it is especially important to recollect, because they, to a great extent, preserve the arch of the foot. They are the long plantar (long calcaneo-cuboid) and the short plantar (short calcaneo-cuboid).

Synovial membranes.—There are six synovial membranes concerned in the articulations of the tarsus and metatarsus. 1. Between os calcis and astragalus, behind the interosseous ligament. 2. Between these bones in front of interosseous ligament and running up between astragalus and scaphoid. 3. Between os calcis and cuboid. 4. Between scaphoid and cuboid, and extending between scaphoid and three cuneiform bones, also between the cuneiform bones to the joints of second and third metatarsals with middle and external cuneiform. 5. Between cuboid and fourth and fifth metatarsals. 6. Between internal cuneiform and first metatarsal.

TARSUS AND METATARSUS.—*Dorsal*, *plantar* and *interosseous* ligaments.

METATARSUS.—*Dorsal*, *plantar* and *interosseous* at bases; a *transverse metatarsal* at heads.

METATARSUS AND PHALANGES.—*Plantar* and two *lateral*.

PHALANGES.—*Plantar* and two *lateral*. In each case the extensor tendons act as dorsal ligaments.

CHAPTER III.

THE MUSCLES.

There are two kinds of muscular tissue; voluntary, or striped (striated), and involuntary, or unstriped (non-striated). The former is frequently called that of animal life, because it is found to constitute the muscles concerned in locomotion and other functions specially pertaining to animals, and is under the influence of their will. The latter is called muscular tissue of organic life, because found in the coats of the involuntary organs. The first variety of muscular fibre is found in the muscles of the limbs, the external muscles of the head and trunk, those of the larynx and tongue; and also in the heart, though this is an organ acting independently of the will. Involuntary, or unstriped, muscle is met with in the walls of the hollow viscera, as the lower part of œsophagus, intestinal tract, trachea, blood-vessels, ureters, and uterus; and in the sexual organs, iris, and skin. The fibres of involuntary muscle form, as a rule, flat sheets, and usually have a peculiar motion. The characteristic of this motion is that one part of the muscular surface slowly contracts, and then slowly relaxes, while an adjacent part contracts. This is easily seen in the peristaltic, or vermicular, motion of the intestines. Under the microscope, involuntary muscle is found to be composed of elongated cells, or bands, in which a rod-shaped nucleus is shown, especially if these cells, or fibres, are treated with acetic acid.

The muscles of animal life, or the striped muscles, consist of bundles surrounded by cellular tissue. These bundles can be split up into smaller bundles, surrounded by cellular tissue, until at last the primitive, or smallest, bundles are reached. In the primitive bundles are seen the primitive fibres, or fibrillæ. The cellular tissue surrounding the larger bundles (larger fasciculi) is called the perimysium; that surrounding the smallest bundles is also perimysium, but is sometimes termed the internal perimysium. The smallest bundles are composed of small fibres, or fibrillæ, each one surrounded by the sarcolemma. If a primitive bundle of voluntary muscle is examined by the microscope, fine dark lines, or striæ, are seen running transversely. Hence this variety is called striped, or striated, muscle. Longitudinal lines are also seen, indicating the fibrils of which the bundle consists. This would seem to show that the fibrils are made up of little cells placed in rows, like a number of beads on a string.

By the origin of a muscle is meant the attachment of its fixed end, by the insertion, that of its more movable extremity; in other words, the origin is that attachment towards which motion takes place. In nearly all cases muscles may act from either extremity, as for example the muscles of the trunk and thighs, which may bend the lower extremities up towards the abdomen, or, if the limbs are held fixed, may flex the trunk over them, as in bowing. Hence the end usually fixed, or that nearer the trunk, is generally called the origin. A muscle is, as a rule, attached to the cartilage and bone by a tendon, which is a cord of fibrous tissue, or by an aponeurosis, which is nothing less than a flattened tendon.

A fascia is a layer of fibrous or fibro-cellular tissue surrounding organs and other structures. The superficial fascia consists of a fibrous network, in the cells of which adipose tissue is deposited. The deep fascia is a dense fibrous membrane investing the muscles and other structures, and thus forming sheaths, or coverings, separating various regions and parts.

MUSCLES OF CRANIUM AND FACE.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
		CRANIAL REGION.		
Occipito-frontal.	1. Superior curved line of occiput, 2. Nasal and internal angular process of frontal,	aponeurosis, aponeurosis,	moves scalp, wrinkles fore head,	post'ior auricular, small occipital, facial.
		AURICULAR REGION.		
Attolens aurem.	aponeurosis of occipito-frontal,	pinna,	raises pinna,	small occipital.
Attrahens aurem.	aponeurosis of occipito-frontal,	helix,	draws pinna forwards,	facial.
Retrahens aurem,	mastoid process,	concha,	draws pinna backwards,	posterior auricular.
		PALPEBRAL REGION.		
Circular of eyelids (orbicularis palpebrarum),	internal margin of orbit,	outer margin of orbit,	closes eyelids,	facial.
Corrugator of eyebrow,	superciliary ridge,	circular of eyelids,	draws eyebrow down and inwards,	facial.
Tensor of tarsal cartilage,	lachrymal bone,	tarsal cartilages,	draws lids and tear canals inward,	facial.

ORBITAL REGION.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Elevator of upper lid,	lesser wing of sphenoid,	upper tarsal cartilage,	lifts upper lid,	third.
Superior rectus,	upper margin of optic foramen,	sclerotic coat,	turns eyeball upward,	third.
Inferior rectus,	lower margin of optic foramen,	sclerotic coat,	turns eyeball downward,	third.
External rectus,	two heads from outer margin of optic foramen,	sclerotic coat,	turns eyeball outwards,	sixth.
Internal rectus,	inner margin of optic foramen,	sclerotic coat,	turns eyeball inwards,	third.
Superior oblique,	above optic foramen,	sclerotic coat,	rotates eyeball,	fourth.
Inferior oblique,	orbital plate of upper maxillary,	sclerotic coat,	rotates eyeball,	third

NASAL REGION.

Pyramidal of nose,	occipito-frontal muscle,	compressor of nose,	draws down eyebrow,	facial.
Elevator of upper lip and wing of nose,	nasal process of upper maxillary,	nasal cartilage and lip,	draws up lip and opens nostril,	facial.
Posterior dilator of nostril,	nasal notch of upper maxillary,	skin at margin of nostril,	dilates the nostril,	facial.
Anterior dilator of nostril,	cartilage of wing of nostril,	skin at margin of nostril,	dilates the nostril,	facial.

NASAL REGION—(*Continued*).

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Compressor of nostril,	superior maxillary,	opposite muscle,	dilates nostril,	facial.
Smaller compressor of nostril,	alar cartilage,	skin at end of nose,	dilates nostril,	facial.
Depressor of wing of nose,	incisive fossa of upper maxillary,	septum and wing of nose,	contracts nostril,	facial.
SUPERIOR MAXILLARY REGION.				
Elevator of upper lip,	lower margin of orbit,	upper lip,	raises lip,	facial.
Elevator of angle of mouth,	canine fossa of upper maxillary,	angle of mouth,	raises angle of mouth,	facial.
Greater zygomatic,	malar bone,	angle of mouth,	raise and draw outward the upper lip,	facial.
Smaller zygomatic,	malar bone,	angle of mouth,		facial.
INFERIOR MAXILLARY REGION.				
Elevator of lower lip,	incissive fossa of lower maxillary,	skin of chin,	raises lower lip and skin of chin,	facial.
Depressor of lower lip,	external oblique line of lower maxillary,	lower lip,	draws lip downwards,	facial.
Depressor of angle of mouth,	external oblique line of lower maxillary,	angle of mouth,	draws down angle of mouth,	facial.

INTER-MAXILLARY REGION.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Circular of mouth (orbicularis oris),	nasal septum and bone below, and canine fossa of lower maxillary; by accessory fibres, or slips,	forms bulk of lips,	closes the mouth,	facial.
Buccinator,	alveolar process of both maxillary bones and pterygo-maxillary ligament,	into circular muscle of mouth,	presses cheek against teeth,	facial.
Risorius,	fascia over masseter,	angle of mouth,	draws out angle of mouth,	facial.

It must be remembered that the muscles of the face are difficult to study, because many of them are small; and some are inserted into the skin; hence, when the skin is removed, one attachment is cut loose. They are muscles of expression, whose duty is to cause such motion of the eyelids, nose, and mouth, and to produce such wrinkles in the integument that the mental emotions may be exhibited. About the mouth a number of small muscles are inserted into a large one, and, as it relaxes, pull it in various directions, so as to alter the shape of the aperture. The mouth is, therefore, a most expressive feature.

MUSCLES OF CRANIUM AND FACE.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
		CRANIAL REGION.		
Occipito-frontal,	1. Superior curved line of occiput,	aponeurosis,	moves scalp,	post'ior auricular, small occipital, facial.
	2. Nasal and internal angular process of frontal,	aponeurosis,	wrinkles forehead,	
		AURICULAR REGION.		
Attolens aurem,	aponeurosis of occipito-frontal,	pinna,	raises pinna,	small occipital.
Attrahens aurem,	aponeurosis of occipito-frontal,	helix,	draws pinna forwards,	facial.
Retrahens aurem,	mastoid process,	concha,	draws pinna backwards.	posterior auricular.
		PALPEBRAL REGION.		
Circular of eyelids (orbicularis palpebrarum),	internal margin of orbit,	outer margin of orbit,	closes eyelids,	facial.
Corrugator of eyebrow,	superciliary ridge,	circular of eyelids,	draws eyebrow down and inwards,	facial.
Tensor of tarsal cartilage,	lachrymal bone,	tarsal cartilages,	draws lids and tear canals inward,	facial.

ORBITAL REGION.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Elevator of upper lid,	lesser wing of sphenoid,	upper tarsal cartilage,	lifts upper lid,	third.
Superior rectus,	upper margin of optic foramen,	sclerotic coat,	turns eyeball upward,	third.
Inferior rectus,	lower margin of optic foramen,	sclerotic coat,	turns eyeball downward,	third.
External rectus,	two heads from outer margin of optic foramen,	sclerotic coat,	turns eyeball outwards,	sixth.
Internal rectus,	inner margin of optic foramen,	sclerotic coat,	turns eyeball inwards,	third.
Superior oblique,	above optic foramen,	sclerotic coat,	rotates eyeball,	fourth.
Inferior oblique,	orbital plate of upper maxillary,	sclerotic coat,	rotates eyeball,	third

NASAL REGION.

Pyramidal of nose,	occipito-frontal muscle,	compressor of nose,	draws down eyebrow,	facial.
Elevator of upper lip and wing of nose,	nasal process of upper maxillary,	nasal cartilage and lip,	draws up lip and opens nostril,	facial.
Posterior dilator of nostril,	nasal notch of upper maxillary,	skin at margin of nostril,	dilates the nostril,	facial.
Anterior dilator of nostril,	cartilage of wing of nostril,	skin at margin of nostril,	dilates the nostril,	facial.

TEMPORO-MAXILLARY REGION.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Masseter,	zygomatic arch,	ramus and angle of jaw,	brings molar teeth together,	inferior maxillary
Temporal,	temporal fossa and fascia,	coronoid process of jaw,	brings incisor teeth together,	inferior maxillary

PTERYGO-MAXILLARY REGION.

Internal pterygoid,	pterygoid fossa of sphenoid,	inner surface of angle of jaw,	raises lower jaw and draws it forwards,	inferior maxillary
External pterygoid,	external pterygoid plate of sphenoid,	neck of condyle,	draws jaw forwards,	inferior maxillary

The action of these muscles in mastication is important. The temporals are the muscles that act when a cutting action of the incisors is required, as in biting an apple; the masseters are the crushing agents exerted in cracking a nut between the molar teeth; while the pterygoids grind the food between the molars by moving the lower jaw laterally and forwards. The deep fibres of the masseters and the posterior fibres of the temporals draw the jaw backward after it has been drawn forward.

MUSCLES OF THE NECK.

SUPERFICIAL CERVICAL REGION.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Platysma myoid,	clavicle, acromion and fascia,	jaw beneath oblique line,	wrinkles skin, draws mouth down,	facial and superficial cervical.
Sterno-cleido-mastoid	sternum and inner end of clavicle,	mastoid process,	bends head forwards and rotates it,	spinal accessory, cervical plexus.

INFRA-HYOID REGION.

Sterno-hyoid,	first piece of sternum, and clavicle,	body of hyoid bone,	draws down hyoid bone,	descending and communicating branches of hypo-glossal.
Sterno-thyroid,	first piece of sternum,	side of thyroid cartilage,	draws down larynx,	hypo-glossal.
Thyro-hyoid,	side of thyroid cartilage,	body and great horn of hyoid,	raises larynx,	hypo-glossal.
Omo-hyoid,	upper border of scapula,	body of hyoid,	draws hyoid downwards,	descending and communicating branches of hypo-glossal.

SUPRA-HYOID REGION.

NAME.		ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Digastric,	anterior belly,	posterior surface of lower jaw near symphysis,	hyoid bone,	raises hyoid bone and tongue.	inferior dental.
	posterior belly,	digastric groove of mastoid process,			facial.
Stylo-hyoid,		styloid process of temporal,	body of hyoid,	draws hyoid up and backwards.	facial.
Mylo-hyoid,		mylo-hyoid ridge of lower jaw,	body of hyoid and middle line,	draws hyoid up and forwards,	inferior dental.
Genio-hyoid,		lower genial tubercle of lower jaw,	body of hyoid,	draws hyoid up and forwards,	hypo-glossal.

TRIANGLES OF THE NECK.

There are five triangular spaces, on each side of the neck, formed by the peculiar location of the muscles. Three triangles are named after arteries, because incisions are made in them when ligation of the artery is to be done; the two other triangles are named after bones, because they are situated below these bones. The arterial triangles are: 1, the superior carotid; 2, the inferior carotid; and 3, the subclavian; the others are: 4, the sub-maxillary, and 5, the sub-occipital. The formation of the cervical triangles will be understood by the following description. The quadrilateral space, formed by the middle line of the neck, the clavicle, the edge of the Trapezius and the line of the body of the lower jaw, is divided into two large triangles by the

Sterno-mastoid muscle. These two primary triangles are divided into four smaller ones by the Omo-hyoid; and finally the upper triangle in front is divided into two by the Digastric, whose two bellies form a small triangle with the border of the jaw. The boundaries are then as follows: —

CERVICAL TRIANGLES.

I. **SUPERIOR CAROTID**, Sterno-mastoid, Omo-hyoid, Digastric (Triangle of Election).
II. **INFERIOR CAROTID**, Sterno-mastoid, Omo-hyoid, Middle Line of Neck (Triangle of Necessity).
III. **SUBCLAVIAN**, Sterno-mastoid, Omo-hyoid, Clavicle.
IV. **SUB-MAXILLARY**, Jaw, two bellies of Digastric.
V. **SUB-OCCIPITAL**, Trapezius, Sterno-mastoid, Omo-hyoid.

LINGUAL REGION.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Genio-hyo-glossus,	upper genial tubercle of lower jaw,	hyoid, and bottom of tongue,	anterior part draws tongue into mouth, posterior part protrudes it,	hypo-glossal.
Hyo-glossus,	great horn of hyoid,	side of tongue,	draws down side of tongue,	hypo-glossal.
Stylo-glossus,	styloid process of temporal,	side of tongue,	draws tongue up and backwards,	hypo-glossal.

PHARYNGEAL REGION.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Inferior constrictor,	cricoid and thyroid cartilages,	posterior median line,	contracts calibre of pharynx,	glosso-pharyngeal.
Middle constrictor,	both horns of hyoid, stylo-hyoid ligament,	posterior median line,	contracts calibre of pharynx,	glosso-pharyngeal.
Superior constrictor,	internal pterygoid plate, and pterygo-maxillary ligament,	posterior median line,	contracts calibre of pharynx,	glosso-pharyngeal.
Stylo-pharyngeus,	styloid process of temporal,	posterior border thyroid cartilage,	draws pharynx up and outwards,	glosso-pharyngeal.

PALATAL REGION.

Elevator of palate,	lower surface of petrous portion of temporal,	middle of soft palate,	raises soft palate,	palatine branches of spheno-palatine ganglion.
Tensor of palate,	scaphoid fossa of sphenoid,	soft palate after curving around hamular process,	makes palate tense,	otic ganglion.
Azygos of uvula,	posterior nasal spine of palate bone,	uvula,	raises uvula (?),	palatine branches of spheno-palatine ganglion.

PALATAL REGION—(*Continued*).

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Palato-glossus,	soft palate,	side and top of tongue,	closes the fauces,	palatine branches of spheno-palatine ganglion.
Palato-pharyngeus,	soft palate,	thyroid cartilage and pharynx,	shuts off upper part of pharynx,	palatine branches of spheno-palatine ganglion.
		LARYNGEAL REGION.		
Crico-thyroid,	front and side of cricoid cartilage,	lower part of thyroid,	stretches cord,	superior laryngeal.
Thyro-arytenoid,	posterior surface of thyroid,	arytenoid,	relaxes vocal cord,	inferior laryngeal.
Lateral crico-arytenoid,	side of cricoid,	angle and external surface of arytenoid,	closes glottis,	inferior laryngeal.
Posterior crico-arytenoid,	back of cricoid,	base of arytenoid,	opens glottis,	inferior laryngeal.
Arytenoid,	back of one arynetoid,	back of other arytenoid,	closes glottis,	both laryngeals.
Thyro-epiglottideus,	inner surface of thyroid,	epiglottis,	depresses epiglottis,	inferior laryngeal.
Superior aryteno-epiglottideus,	apex of arytenoid,	fold between epiglottis and arytenoid,	constricts aperture of larynx,	inferior laryngeal.
Inferior aryteno-epiglottideus,	arytenoid,	epiglottis,	compresses saccule of larynx,	inferior laryngeal.

ANTERIOR VERTEBRAL REGION.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Great anterior rectus of head,	transverse processes 3d–6th cervical,	basilar process,	flexes head,	cervical plexus.
Small anterior rectus of head,	transverse process and lateral mass of atlas,	basilar process,	flexes head,	cervical plexus.
Lateral rectus,	transverse process of atlas,	jugular process,	bends head laterally,	cervical plexus.
Long of neck,				
superior oblique portion,	transverse processes 3d–5th cervical,	anterior tubercle of atlas,	flexes cervical vertebræ,	lower cervical.
inferior oblique portion,	bodies of first three dorsal,	transverse processes 5th–6th cervical,		
vertebral portion,	bodies of three dorsal and three cervical,	bodies of 2d–4th cervical,		

LATERAL VERTEBRAL REGION.

Anterior scalene,	tubercle of first rib,	transverse processes 3d – 6th cervical,	bends neck laterally,	lower cervical.
Middle scalene,	first rib,	transverse processes six lower cervical,	bends neck laterally,	lower cervical.
Posterior scalene,	second rib,	transverse processes three lower cervical,	bends neck laterally,	lower cervical.

POSTERIOR VERTEBRAL REGION.

This region will be considered with the muscles of the back, which overlie the posterior vertebral muscles of the neck.

MUSCLES OF THE BACK.

In tabulating these muscles certain abbreviations will be employed, in order to make the descriptions less extended:—*T*, for transverse process; *S*, for spinous process; *A*, for articular process; *C*, for cervical vertebræ; *D*, for dorsal vertebræ; *L*, for lumbar vertebræ.

FIRST LAYER.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Trapezius,	superior line of occipital, all *S* to 12th *D*,	clavicle and spine of scapula,	draws head backwards,	spinal accessory, cervical plexus.
Broad dorsal (Latissimus dorsi),	*S* of 6 lower *D*, *S* of *L*, *S* of sacrum, crest of ilium and lower ribs,	bicipital groove of humerus,	draws arm backwards and downwards,	sub-scapular.

SECOND LAYER.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Elevator of angle of scapula,	*T* of 4 upper *C*,	border of scapula below upper angle,	raises upper angle of scapula,	fifth cervical.
Lesser rhomboid,	*S* of last *C* and first *D*,	border of scapula at root of spine,	draws scapula backwards,	fifth cervical.
Greater rhomboid,	*S* of 5 upper *D*,	border of scapula to lower angle,	draws scapula backwards,	fifth cervical.

THIRD LAYER.

Superior posterior serrated,	*S* last 2 *C* and first 2 *D*,	4 upper ribs,	raises ribs in inspiration,	posterior branches of cervical.
Inferior posterior serrated,	*S* last 2 *D* and first 2 *L*,	4 lower ribs,	depresses ribs in expiration,	posterior branches of dorsal.
Splenius of head and neck,	half of ligament of nape and *S* 6 upper *D*,	1. Occiput and mastoid, 2. *T* 4 upper *C*,	draws head back, keeps neck erect,	posterior branches of cervical.

FOURTH LAYER.

This layer is composed of the Erector of the spine with its prolongations, the Spinals of the back and neck, and the Complexus. The Erector of the spine will be better understood, if it be stated that it fills the groove between the sacral spines and the ilium; and that, at the level of the lowest rib, it subdivides into two masses of muscle. The outer is attached to the angles of the ribs, and is called the Sacro-lumbar; it is continued upwards by the Accessory muscle of the

Sacro-lumbar, and the Ascending of the neck. Each of these in turn takes its origin where the one below was inserted. The inner sub-division of the Erector of the Spine, called Long dorsal, is attached to the transverse processes of the vertebræ, and, in a manner similar to the outer subdivision, is continued up the back and neck by the Transverse of the neck and the Trachelo-mastoid.

Erector of Spine, ORIGIN. Crest of ilium, back of sacrum, lumbar spines ; divides into	*Sacro-lumbalis.* insertion — 6 lower ribs,	*Accessory.* origin — 6 lower ribs, insertion — 6 upper ribs,	*Ascending of neck.* origin — 6 upper ribs, insertion *T* of 4 lower *C*.
	Long dorsal. insertion *T*, of lumbar and dorsal (and 6 lower ribs,)	*Transverse of neck.* origin *T* 6 upper *D*, insertion *T* 6 lower *C*,	*Trachelo-mastoid.* origin *T* 6 upper *D*, and *A* 6 lower *C*. insertion mastoid process.

NAME.	ORIGIN.	INSERTION.	ACTION.
Spinal of back,	*S* of first 2 *L* and last 2 *D*,	*S* of 4 upper *D*,	straightens spine.
Spinal of neck,	*S* of first 2 *D* and last 2 *C*,	*S* of 4 upper *C*,	straightens spine.
Complexus,	*T* of first 3 *D*, and *A* of last 3 *C*,	occipital between curved lines,	draws head backwards.

Double bellied of neck (Biventer cervicis) is merely a part of Complexus.

The action of all the muscles of the fourth layer, except the Trachelo-mastoid and the Complexus, is to straighten the spine and keep it erect; the two mentioned are attached to the head, and serve to hold it erect and draw it backwards. The nervous supply is derived from the posterior branches of the spinal nerves in the cervical, dorsal, lumbar and sacral regions respectively.

FIFTH LAYER.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Great posterior rectus of head,	spine of axis,	inferior line of occiput,	rotates atlas and head,	great occipital.
Small posterior rectus of head,	rudimentary spine of atlas,	below inferior line of occiput,	draws head backwards,	great occipital.
Inferior oblique,	spine of axis,	transverse process of atlas,	rotates atlas and head,	great occipital.
Superior oblique,	transverse process of atlas,	between lines of occiput,	draws head backwards,	great occipital.
Semi-spinal of back,	*T* of lower dorsal,	*S* of upper dorsal,	keeps spine erect,	posterior branches of dorsal.
Semi-spinal of neck,	*A* of lower cervical,	*S* of upper cervical,	keeps spine erect,	posterior branches of cervical.

The other muscles of this layer are not of sufficient importance to be studied. They are Multifidus Spinæ, Rotators of Spine, Supra-spinals, Inter-spinals, Inter-transverse, Extensor of Coccyx.

MUSCLES OF THE ABDOMEN.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
External oblique,	eight lower ribs,	middle line, crest of ilium, Poupart's ligament,	compresses viscera and flexes thorax,	intercostal, ilio-hypogastric, ilio-inguinal.
Internal oblique,	Poupart's ligament, crest of ilium, lumbar fascia,	middle line, crest of pubes, four lower ribs,	compresses viscera and flexes thorax,	intercostal, ilio-hypogastric, ilio-inguinal.
Transverse,	Poupart's ligament, crest of ilium, six lower ribs,	middle line, crest of pubes,	compresses viscera and flexes thorax,	intercostal, ilio-hypogastric, ilio-inguinal.
Rectus,	crest of pubes,	cartilages of 5th, 6th, 7th ribs,	bends chest forwards,	intercostal, ilio-hypogastric, ilio-inguinal.
Pyramidal,	pubes,	middle line,	tensor of middle line,	ilio-hypogastric.
Quadrate of loins,	crest of ilium,	12th rib and transverse processes of 3 lower *L* vertebræ,	bends chest laterally,	lumbar.

MUSCLES OF THE THORAX.

External intercostal (11),	outer lip of lower border of ribs,	upper border of ribs,	inspiration,	intercostal.
Internal intercostal (11),	inner lip of lower border of ribs,	upper border of ribs,	expiration,	intercostal.

MUSCLES OF THE THORAX—(*Continued.*)

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Infracostal (10),	inner surface of ribs near angles,	inner surface of 2 or 3 ribs below,	inspiration,	intercostal.
Triangular of sternum,	inner surface of lower part of sternum and costal cartilages,	back of costal cartilages above,	expiration,	intercostal.
Elevators of ribs (12),	transverse processes of dorsal vertebræ,	rib below, in front of tubercle,	inspiration,	intercostal.
DIAPHRAGMATIC REGION.				
Diaphragm,	posterior surface of ensiform and lower costal cartilages, arcuate ligaments, three lumbar vertebræ,	central tendon,	inspiration,	phrenic.
PERINEAL REGION.				
Sphincter of anus,	tip of coccyx,	central tendon of perineum,	closes anus,	hemorrhoidal.
Accelerator of urine,	central tendon of perineum,	bulb, spongy and cavernous part of penis,	ejects urine,	perineal.
Erector of penis,	tuberosity and ramus of ischium,	root of penis,	maintains erection,	perineal.
Transverse of perineum,	ramus of ischium,	central tendon,	tensor of middle line,	perineal.

PERINEAL REGION—(*Continued*).

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Elevator of anus,	posterior surface of pubes, spine of ischium,	rectum and coccyx,	raises rectum,	sacral and perineal.
Compressor of urethra,	ramus of pubes,	opposite muscle,	compresses urethra,	perineal.
Coccygeus,	spine of ischium,	coccyx,	flexes coccyx,	sacral.

In females we have Erector of clitoris instead of Erector of penis, and the Sphincter of vagina instead of the Accelerator of the urine.

MUSCLES OF THE UPPER EXTREMITY.

ANTERIOR THORACIC REGION.

Greater pectoral,	clavicle, sternum, costal cartilages,	anterior bicipital ridge of humerus,	draws arm down and across chest,	anterior thoracic.
Lesser pectoral,	third, fourth, and fifth ribs,	coracoid process of scapula,	depresses point of shoulder,	anterior thoracic.
Subclavius,	cartilage of first rib,	lower surface of clavicle,	draws clavicle downwards,	fifth and sixth cervical.

LATERAL THORACIC REGION.

Great serrated,	eight upper ribs,	Anterior surface of posterior border of scapula,	inspiration,	posterior thoracic.

ACROMIAL REGION.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Deltoid,	clavicle, acromion, spine of scapula,	outside of shaft of humerus,	raises arm,	circumflex.
ANTERIOR SCAPULAR REGION.				
Subscapular,	subscapular fossa,	lesser tuberosity of humerus,	internal rotator,	subscapular.
POSTERIOR SCAPULAR REGION.				
Supra-spinate,	supraspinous fossa.	great tuberosity of humerus,	holds head of humerus in socket,	supra-scapular.
Infra-spinate,	infraspinous fossa,	great tuberosity of humerus,	external rotator,	supra-scapular.
Lesser teres,	axillary border of scapula,	great tuberosity of humerus,	external rotator,	circumflex.
Greater teres,	inferior angle of scapula,	posterior bicipital ridge of humerus,	draws arm down and back,	sub-scapular.
ANTERIOR HUMERAL REGION.				
Coraco-brachial,	coracoid process of scapulæ,	inside of shaft of humerus,	draws arm forwards and inwards,	musculo-cutaneous.

ANTERIOR HUMERAL REGION—(*Continued*).

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Biceps,	1, coracoid process and 2, top of glenoid cavity,	back of tuberosity of radius,	flexor and supinator of forearm,	musculo-cutaneous.
Anterior brachial,	lower part of front of humerus,	base of coronoid process of ulna,	flexes forearm,	musculo-cutaneous and musculo-spiral.

POSTERIOR HUMERAL REGION.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Triceps,	*long head*, lower margin of glenoid cavity, *external head*, above musculo-spiral groove, *internal head*, below musculo-spiral groove,	olecranon process,	extends forearm,	musculo-spiral.
Subanconeus,	humerus above olecranon fossa,	posterior ligament of elbow joint,	tensor of ligament (?)	musculo-spiral.

MUSCLES OF THE FOREARM.

Anterior Brachial Region.

SUPERFICIAL LAYER.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Round pronator of radius,	internal condyle and coronoid process,	outside of shaft of radius,	pronates hand,	median.
Radial flexor of wrist,	internal condyle,	base of 2d metacarpal,	flexes wrist,	median.
Long palmar,	internal condyle,	palmar fascia,	tensor of fascia,	median.
Ulnar flexor of wrist,	internal condyle and ulna,	base of 5th metacarpal,	flexes wrist,	ulnar.
Superficial flexor of fingers,	internal condyle, coronoid process, oblique line of radius,	secondphalanges,	flexes second phalanges,	median.

DEEP LAYER.

Deep flexor of fingers,	shaft of ulna,	last phalanges,	flexes last phalanges,	ulnar and anterior interosseous.
Long flexor of thumb,	shaft of radius,	last phalanx of thumb,	flexes last phalanx of thumb,	anterior interosseous.
Square pronator,	lower part of ulna,	lower part of radius,	pronates hand,	anterior interosseous.

Radial Region.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Long supinator,	external condyloid ridge of humerus,	styloid process of radius,	supinates hand,	musculo-spiral.
Long radial extensor of wrist,	external condyloid ridge of humerus,	base of 2d metacarpal,	extends wrist,	musculo-spiral.
Short radial extensor of wrist,	external condyloid ridge of humerus,	base of 3d metacarpal,	extends wrist,	posterior interosseous.

Posterior Brachial Region.

SUPERFICIAL LAYER.

Common extensor of fingers,	external condyle of humerus,	phalanges,	extends fingers,	posterior interosseous.
Extensor of little finger,	external condyle of humerus,	phalanges of little finger,	extends little finger,	posterior interosseous.
Ulnar extensor of wrist,	external condyle of humerus,	base of 5th metacarpal,	extends wrist,	posterior interosseous.
Anconeus,	back of external condyle,	olecranon and posterior part of ulna,	extends forearm,	musculo-spiral.

DEEP LAYER.

Short supinator,	external condyle of humerus, back of ulna,	neck and back of radius,	supinates hand,	posterior interosseous.
Extensor of metacarpal of thumb,	back of radius and ulna,	base of metacarpal of thumb,	extends thumb,	posterior interosseous.

DEEP LAYER—(*Continued*).

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Extensor of first phalanx of thumb,	back of radius,	base of 1st phalanx of thumb,	extends thumb,	posterior interosseous.
Extensor of second phalanx of thumb,	back of ulna,	base of 2d phalanx of thumb,	extends thumb,	posterior interosseous.
Extensor of index,	back of ulna,	2d and 3d phalanges of index,	extends forefinger,	posterior interosseous.

A rule which will enable the student to remember the origins of many of these muscles is as follows: The extensors and supinators arise from the external condyle of the humerus, the flexors from the internal condyle. The exceptions to the rule are the extensors of the thumb and forefinger, and the flexors of thumb and little finger and deep flexor of the fingers.

MUSCLES OF THE HAND.

THUMB.

Abductor of thumb,	trapezium,	first phalanx of thumb,	draws thumb from hand,	median.
Flexor of metacarpal of thumb,	trapezium,	metacarpal of thumb,	flexes metacarpal,	median.
Short flexor of thumb,	trapezium, os magnum, 3d metacarpal,	first phalanx,	flexes thumb,	median and ulnar.
Adductor of thumb,	third metacarpal,	first phalanx,	draws thumb towards hand,	ulnar.

LITTLE FINGER.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Short palmar,	annular ligament and palmar fascia,	skin of palm,	wrinkles skin,	ulnar.
Abductor of little finger,	pisiform bone,	first phalanx of little finger,	draws finger away from the rest,	ulnar.
Short flexor of little finger,	unciform bone,	first phalanx of little finger,	flexes little finger,	ulnar.
Flexor of metacarpal of little finger,	unciform bone,	metacarpal of little finger,	flexes metacarpal and draws finger toward the rest,	ulnar.
MIDDLE OF HAND.				
Lumbrical (four),	tendons of deep flexor,	back of phalanges,	flex first phalanges (?),	median and ulnar.
Dorsal interosseous (four),	sides of metacarpal bones,	back of phalanges,	abduct fingers from middle line of middle finger,	ulnar.
Palmar interosseous (three),	palmar surface of metacarpals,	side of phalanges,	adduct fingers towards middle line of middle finger,	ulnar.

The action of the Dorsal interosseous muscles is to draw the fingers to which they are attached away from the middle line of the hand. As the thumb and little finger have each a special Abductor there is no necessity for an Interosseous to do this duty, hence four are sufficient; one for the forefinger (sometimes called the Abductor of the index), one for the ring finger, and one attached to each side of the middle finger, to move it each side of the median line. The Palmar interosseous act as adductors, and draw the fingers towards the middle line, or middle finger. There are three of them, one for the little finger, one for the ring finger, and one for the index finger: the thumb, as already described, has a special Adductor, and the middle finger requires none, because it has an Abductor on each side to move it in the two directions. These muscles also have part in the flexion and extension of the finger joints, and are associated with the Lumbricals. It is difficult to obtain their action by dissection alone, because the tendons are small and the insertions blended; but dissection and pathological conditions of the nerves supplying them seem to favor the following view:—

NAME.	FLEXED BY	EXTENDED BY
First phalanges,	interosseous and lumbricals,	common extensor of fingers.
Second phalanges,	superficial flexor of fingers,	interosseous and lumbricals.
Third phalanges,	deep flexor of fingers,	interosseous and lumbricals.

MUSCLES OF LOWER EXTREMITY.

ILIAC REGION.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Greater psoas,	bodies and transverse processes of last dorsal and all the lumbar vertebræ,	lesser trochanter of femur,	flexes, and rotates thigh outward,	lumbar.

ILIAC REGION—(*Continued*).

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Smaller psoas,	bodies of last dorsal and first lumbar vertebræ,	iliac fascia,	tensor of iliac fascia,	lumbar.
Iliac,	iliac fossa and base of sacrum,	below lesser trochanter,	flexes, and rotates thigh outwards,	anterior crural.

ANTERIOR FEMORAL REGION.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Tensor of sheath of thigh,	crest of ilium and anterior superior spine,	fascia lata,	tightens deep fascia of thigh,	superior gluteal.
Sartorius,	anterior superior spine of ilium	upper and inner part of tibia,	flexes and crosses legs,	anterior crural.
Rectus,	anterior inferior spine and top of acetabulum,	patella, “Four-headed” extensor of leg.		anterior crural.
External vast,	external lip of rough line of femur, and base of greater trochanter,	patella,	inserted by ligament of patella into tubercle of tibia to extend the leg,	anterior crural.
Internal vast,	internal lip of rough line of femur,	patella,		
Crureus,	front of shaft of femur,	patella,		
Sub-crureus,	front of lower part of femur,	synovial sac,	pulls sac upwards,	anterior crural.

POSTERIOR FEMORAL REGION—(*Continued*).

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Semi-tendinous,	tuberosity of ischium,	upper and inner part of tibia,	flexes leg,	great sciatic.
Semi-membranous,	tuberosity of ischium,	back of inner tuberosity of tibia,	flexes leg, rotates inward,	great sciatic.

MUSCLES OF THE LEG.

ANTERIOR TIBIO-FIBULAR REGION.

Anterior tibial,	outside of head and shaft of tibia,	internal cuneiform and first metatarsal,	flexes ankle,	anterior tibial.
Extensor of great toe,	middle of shaft of fibula,	last phalanx of great toe,	extends toe,	anterior tibial.
Long extensor of toes,	head of tibia and shaft of fibula,	2d and 3d phalanges of toes,	extends toes,	anterior tibial.
Third peroneal,	lower part of shaft of fibula,	fifth metatarsal,	flexes ankle,	anterior tibial.

POSTERIOR TIBIO-FIBULAR REGION.

Superficial Layer.

Gastrocnemius,	two heads above condyles of femur,	os calcis, by tendon of Achilles.	extends foot;	internal popliteal.
Soleus,	shaft of fibula, oblique line of tibia,	os calcis,	extends foot,	internal popliteal.
Plantaris,	above outer condyle of femur,	os calcis,	extends foot,	internal popliteal.

POSTERIOR TIBIO-FIBULAR REGION—(*Continued*).

Deep Layer.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Popliteus,	outside of external condyle of femur,	tibia above oblique line,	flexes leg,	internal popliteal.
Long flexor of great toe,	shaft of fibula,	last phalanx of great toe,	flexes toe,	posterior tibial.
Long flexor of toes,	shaft of tibia,	last phalanges of toes,	flexes toes,	posterior tibial.
Posterior tibial,	shaft of tibia and fibula,	scaphoid and internal cuneiform,	extends ankle,	posterior tibial.

FIBULAR REGION.

Long peroneal,	head and outside of shaft of fibula,	base of metatarsal of great toe,	extends ankle and everts foot,	musculo-cutaneous.
Short peroneal,	outside of shaft of fibula,	base of fifth metatarsal,	extends ankle and everts foot,	musculo-cutaneous.

MUSCLES OF THE FOOT.

DORSAL REGION.

Short extensor of toes,	outside of os calcis,	first phalanx of great toe and tendons of long extensor,	extends toes,	anterior tibial.

PLANTAR REGION.

First Layer.

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Abductor of great toe,	inner tubercle of os calcis,	first phalanx of great toe,	draws toe away from others,	internal plantar.
Short flexor of toes,	inner tubercle of os calcis, and plantar fascia,	second phalanges of toes,	flexes toes,	internal plantar.
Abductor of little toe,	outer tubercle of os calcis,	first phalanx of little toe,	draws toe away from others,	external plantar.
Second Layer.				
Accessory flexor,	1, inner surface of os calcis, 2, outer surface of os calcis,	tendons of Long flexor of toes,	prevents Long flexor from pulling obliquely,	external plantar.
Lumbricals (four),	tendons of Long flexor,	bases of first phalanges,	flex toes (?),	internal and external plantar.
Third Layer.				
Short flexor of great toe,	cuboid,	base of first phalanx of great toe,	flexes great toe,	internal plantar.
Abductor of great toe,	base of 2d, 3d and 4th metatarsal,	base first phalanx of great toe,	draws great toe towards middle line of foot,	external plantar.

PLANTAR REGION—(*Continued*).

NAME.	ORIGIN.	INSERTION.	ACTION.	NERVOUS SUPPLY.
Short flexor of little toe,	base of 5th metatarsal,	base first phalanx of little toe,	flexes little toe,	external plantar
Transverse of foot,	head of 5th metatarsal,	first phalanx of great toe,	draws great toe towards middle line of foot (?)	external plantar.

Fourth Layer.

Dorsal interosseous (four),	sides of metatarsals,	side and back of first phalanges,	draw toes away from middle line of 2d toe,	external plantar.
Plantar interosseous (three),	under surface of metatarsals,	back of first phalanges,	draw toes towards middle line of 2d toe,	external plantar.

The Interosseous muscles, like those in the hand, have, in addition to their action as abductors and adductors, some agency in flexing and extending the phalanges. Their anatomy would lead us to suppose that the action was similar to that demonstrated in the upper extremity. It is to be observed that the Interosseous muscles of the foot adduct to and abduct from the middle line of the *second* toe, instead of the third, as in the hand. The four Dorsal interosseous are inserted as follows: two into the second, one into the third, and one into the fourth toe; because the great and little toe have each a special Abductor. The three Plantar muscles are attached to the third, fourth and fifth toes, since the great toe has a special Adductor, and the second needs none, because moved each way by the abducting Dorsal interosseous.

CHAPTER IV.

THE VASCULAR SYSTEM.

The vascular system consists of the heart, arteries, capillaries and veins; to which may be added the lymphatic vessels and glands. The circulation of the blood may be divided into two circles, the pulmonary and the systemic; which will be better understood if the direction of the blood current be described. The heart is a pump, forcing the venous blood through the lungs to become supplied with oxygen, and the arterial blood to the extremities and organs of the body to carry on the various nutritive processes there required. The heart itself will be described with the thoracic viscera; but it is necessary, at this point, to state that the right side of the heart receives the impure blood, or that coming from the veins and containing carbonic acid, and sends it through the pulmonary artery to the lungs. Here it absorbs oxygen and returns by the pulmonary veins to the left side of the heart, whence it is driven, through the aorta and its branches, to the tissues of every region. The smallest arteries open into small tubes called capillaries, which in turn empty into the smallest veins; these gradually unite with other veins and finally pour the blood, which is now full of carbonic acid and wanting in oxygen, into the venæ cavæ. These largest veins open into the right side of the heart, after which the round of the pulmonary and then that of the systemic circulation is gone over again.

Arteries consist of three coats, an internal or serous, a middle or muscular and elastic, and an external or connective tissue coat. They are usually enclosed in a sort of loose bag called the sheath, which in many cases also surrounds the vein accompanying the artery. Arteries have small nerves and very small arteries running in their walls, to supply proper nerve force and blood to the cells of which they are composed. The capillaries have, as a rule, but one very thin transparent coat; while the veins have three, like the arteries, though the middle coat is much weaker than that of the arteries. The veins are supplied in many regions with valves, which are formed of a folding inwards of the inner and part of the middle coat. The following veins have no valves, because the current of blood seems not to require them: venæ cavæ, hepatic, portal, renal, uterine and ovarian, cerebral, spinal, and pulmonary.

THE ARTERIES.

THE AORTA.

The aorta is the main trunk from which the arteries of the systemic circulation receive their blood. It commences at the top of the left ventricle, makes a curve across to the left side of the vertebral column, passes down between the peduncles of the diaphragm. and, opposite the body of the fourth lumbar vertebra, divides into the two common iliac arteries. It is divided, for description, into three parts: the arch, extending from the heart to the lower border of the body of the fourth dorsal vertebra; the thoracic aorta, from the lower border of the fourth dorsal to the body of the last dorsal, where the opening in the diaphragm is situated; and the abdominal aorta, extending from the diaphragm to the body of the fourth lumbar vertebra. The arch is divided into the ascending, transverse and descending parts. The ascending extends from a point, corresponding with the middle of the sternum, on a level with the third costal cartilage, to the upper border of the second right costal cartilage; the transverse from the latter point to the left side of third dorsal vertebra,. whence the descending portion is continued to the lower border of fourth vertebra. The arch curves over the root of the left lung; the thoracic aorta lies behind the left pleura, and the abdominal behind the peritoneum.

The branches of the aorta are as follows:—

From the Arch.

1. Two coronary,
2. An innominate,
3. Left common carotid,
4. Left subclavian.

From the Thoracic.

5. Pericardials,
6. Bronchials,
7. Œsophageals,
8. Posterior mediastinals,
9. Twenty intercostals.

From the Abdominal.

10. Two phrenic,
11. A cœliac axis,
12. A superior mesenteric,
13. Two suprarenal,
14. Two renal,
15. Two spermatic,
16. An inferior mesenteric,
17. Eight lumbar,
18. A middle sacral,
19. And terminates in two common iliacs.

CORONARY.—The coronary arteries are given off at the beginning of the arch of the aorta, behind the semi-lunar valves, and run in the grooves between the right and left sides of the heart. The left artery occupies the anterior groove.

INNOMINATE.—This trunk arises from the summit of the aortic arch, and proceeds to the right sterno-clavicular junction, where it divides into the right common carotid and right subclavian. The left common carotid and the left subclavian arise directly from the arch of the aorta.

COMMON CAROTID.—Though the arteries of the two sides of the neck have a different origin, their branches and distribution are similar, since the left carotid soon reaches the left sterno-clavicular junction, and is then identical with the right. A line, drawn from the sterno-clavicular articulation to a point midway between the mastoid process and angle of the lower jaw, indicates the course of the vessel, which bifurcates, however, into the external and internal carotids at the level of the top of the thyroid cartilage. The artery is crossed about the middle of its course by the Omo-hyoid muscle, and lies under the inner border of the Sterno-mastoid muscle. In the sheath of the artery are enclosed the internal jugular vein on the outer side, and the pneumogastric nerve. On the front surface of the sheath lies the descending branch of the hypoglossal nerve. The common carotid has no branches except the terminal ones already mentioned, of which the internal carotid is the one further from the median line.

EXTERNAL CAROTID.—This artery is so called because it supplies the external portion of the head, and not because of its location in regard to the other artery, which, though external in situation, is called the internal carotid, on account of its supplying the interior of the cranium. The external carotid extends from the bifurcation of the common carotid, at the top of the larynx, to the neck of the condyle of the lower jaw; here it terminates by dividing into the temporal and internal maxillary. Its course is a continuation of the line of the common carotid artery.

The branches of the external carotid and the important sub-branches are as follows:—

1. *Superior Thyroid*, given off below hyoid bone, runs to thyroid gland:—
   muscular,
   hyoid,
   sterno-mastoid,
   superior laryngeal.
   crico-thyroid.
2. *Lingual*, runs under Hyoglossus muscle:—
   hyoid,
   dorsal of tongue,
   sublingual.
   ranine.
3. *Facial*, crosses lower jaw in front of masseter:—

Cervical branches.	*Facial branches.*
ascending palatine,	muscular,
	inferior labial.
tonsillar,	inferior coronary.
submaxillary,	superior coronary.
submental,	lateral nasal.
	angular.

4. *Occipital*, passes beneath Digastric and lies in groove under mastoid process:—
   muscular,
   auricular,
   inferior meningeal,
   principal of neck (princeps cervicis),
   cranial.
5. *Posterior auricular*, ascends through parotid gland behind auricle:—
   stylo-mastoid,
   auricular.
6. *Ascending pharyngeal*, lies on Greater anterior rectus of head and ascends to base of the skull:—
   external,
   pharyngeal,
   meningeal.
7. *Temporal*, is one of the terminal branches of the external carotid, and, traversing the parotid gland, crosses the zygomatic arch and divides into anterior and posterior temporal:—
   transverse facial,
   middle temporal,
   anterior auricular,
   anterior temporal,
   posterior temporal.
8. *Internal maxillary*, the larger terminal branch, is divisible into three portions, according to its location in different parts of its course.

The Maxillary portion runs directly forwards between the ramus of the jaw and the internal lateral ligament:—

tympanic,
small meningeal,
middle meningeal,
inferior dental, dividing into incisor and mental.

The Pterygoid portion runs upwards and forwards upon the External pterygoid muscle:—

deep temporal,
masseteric,
pterygoid,
buccal.

The Spheno-Maxillary portion lies in the spheno-maxillary fossa and curves upwards, usually piercing the External pterygoid muscle:—

alveolar, giving off superior dental,
infraorbital,
posterior or descending palatine,
Vidian,
pterygo-palatine,
naso-palatine.

The teeth, then, are supplied with blood as follows:—Those of the lower jaw receive blood from the first portion of the internal maxillary by the inferior dental branch, and by the incisor, its continuation. In the upper jaw, the molars and bicuspids are supplied by the superior dental branch of the alveolar, coming from the third portion of the internal maxillary, and the front teeth by small branches from the infraorbital, coming also from the internal maxillary.

THE INTERNAL CAROTID, starting at the point of bifurcation of the common carotid, opposite the top of the larynx, ascends and enters the cranium through the carotid canal, in the petrous portion of the temporal bone. In the first, or cervical, portion of its course, the artery runs almost vertically up the neck to the petrous portion of the temporal bone. It is in relation with the internal jugular vein and pneumogastric nerve, lying at its outer side, and with the pharynx and tonsil on its inner side. The petrous portion lies in the temporal bone and makes abrupt curves during its passage through the canal; the cavernous portion lies at the inner side of the cavernous sinus, extending to the anterior clinoid process; the cerebral portion is short, and curving upwards from this point pierces the dura mater.

Branches of internal carotid—
From cervical portion, *none.*
" petrous " *tympanic.*
" cavernous " { *anterior meningeal,*
ophthalmic.
from which
lachrymal,
supra-orbital,
anterior ethmoidal,
posterior "
palpebral,
frontal,
nasal.
muscular,
anterior ciliary,
short ciliary,
long ciliary,
central of retina,
" cerebral " *posterior communicating,*
anterior cerebral,
anterior communicating,
middle cerebral,
anterior choroid.

The circle of Willis is a name given to the anastomosis of the branches of the two internal carotid and two vertebral arteries at the base of the brain. The two vertebrals form a large trunk called the basilar, which gives off, besides other branches, two posterior cerebrals. The circle is then formed
by two anterior cerebral,
two middle cerebral,
two posterior cerebral,
two posterior communicating,
one anterior communicating.

These anastomose in the following manner: the two anterior cerebrals are joined together by the anterior communicating, and the middle cerebral of each side is joined to the corresponding posterior cerebral by a posterior communicating.

THE ARTERIES OF THE UPPER EXTREMITY.

THE SUBCLAVIAN is considered the first artery of the upper extremity, although some of its branches are distributed to the head and neck. The subclavian may be regarded as divided into three portions by the Anterior scalene muscle, viz., the part internal, that behind, and that external to the muscle. The first part has different relations on the two sides, on account of the difference in origin. On the right side the artery is formed with the common carotid by the bifurcation of the innominate; on the left side it is given off directly by the transverse portion of the arch of the aorta. Hence on the left side it is longer, and ascends almost vertically to the inner border of the Anterior scalene, while on the right side it arches upwards and outwards to that point. The subclavian extends to the outer border of the first rib, where it becomes the axillary. It projects a little above the clavicle, and is separated from the subclavian vein by the Anterior scalene muscle.

Its branches are as follows, all given off from the first portion, except the last, which, on the right side, arises from the second portion.

Vertebral, ascending through transverse processes of six cervical vertebræ, and entering skull by the great foramen:—
- lateral spinal,
- muscular,
- posterior meningeal,
- anterior spinal,
- posterior spinal,
- inferior cerebellar,
- basilar,
  (formed by union of both vertebrals, lies along middle of pons Varolii). The branches of the basilar are:—
  - transverse,
  - anterior cerebellar,
  - superior cerebellar,
  - posterior cerebral.

Thyroid axis,
- inferior thyroid,
  - laryngeal,
  - tracheal,
  - œsophageal,
  - ascending cervical,
- suprascapular,
- transverse of neck,
  - superficial cervical,
  - posterior scapular,

Internal mammary, running on inside of cartilages, parallel to sternum:—
- superior phrenic,
- pericardiac,
- anterior intercostal,
- perforating,
- musculo-phrenic.
- superior epigastric.

Superior Intercostal,
- deep cervical.

AXILLARY.—This is the continuation of the subclavian, and extends from the outer border of the first rib to the lower margin of the tendons of the armpit muscles. The

Lesser pectoral muscle divides it into three parts, that internal, that behind, and that external to the muscle.

- superior thoracic,
- acromial thoracic,
- long thoracic,
- alar thoracic,
- subscapular,
- dorsal of scapula,
- anterior circumflex,
- posterior circumflex.

BRACHIAL.—The brachial is the continuation of the axillary, and runs at first along the inner border of the Coraco-brachial and Biceps, but finally gets to the front of the arm and terminates at a point about half an inch below the elbow, where it divides into radial and ulnar. Its branches are—

- superior profunda,
- nutrient,
- inferior profunda,
- great anastomotic,
- muscular.

Radial from bifurcation of the brachial to deep palmar arch of hand. It runs between the Long supinator and the Radial extensor of the wrist, and has the radial nerve to its radial side. It curves around the base of the thumb on the outside, and then forms the deep palmar arch.

- radial recurrent,
- muscular,
- superficial volar,
- anterior carpal,
- posterior carpal,
- metacarpal,
- dorsal of thumb (two),
- dorsal of index finger,
- principal of thumb,
- radial of the index,
- perforating,
- interosseous.

Ulnar.—From bifurcation of brachial to superficial palmar arch. At first it is deeply situated, but then runs between the Ulnar flexor of wrist and the Superficial flexor of fingers, with the ulnar nerve to its ulnar side. It forms the superficial palmar arch, anastomosing with the superficial volar.

- anterior ulnar recurrent,
- posterior ulnar recurrent,
- interosseus.
  - anterior,
  - posterior,
- muscular,
- anterior carpal,
- posterior capal,
- deep branch,
- digital.

Palmar Arches.—The superficial palmar arch is the termination of the ulnar, and lies on a line with the anterior border of the extended thumb; while the deep arch, the termination of the radial, is about a finger's breadth behind this. The arches are connected by the superficial volar and deep branch of ulnar. The fingers are each supplied by two arteries on the dorsal and two on the palmar surface, which come from the arches directly, or from their interosseous branches.

THORACIC AORTA.

The thoracic aorta extends from lower border of fourth dorsal vertebra to body of last dorsal. This portion of the aorta and its branches have been described sufficiently on a previous page.

Abdominal Aorta, from the body of last dorsal to body of fourth lumbar vertebra. Its branches have been given, but must be recapitulated, in order to show their distribution:—

- *Phrenic*, or diaphragmatic.
- *Cœliac axis*,
  - GASTRIC, to stomach.
  - HEPATIC, to liver, etc.
    - pyloric,
    - gastro-duodenal,
      - right gastro-epiploic,
      - superior pancreatico-duodenal,
    - cystic,
  - SPLENIC, to spleen, etc.
    - pancreatic,
    - left gastro-epiploic,
    - gastric branches (vasa brevia).
- *Superior mesenteric*,
  - inferior pancreatico-duodenal,
  - small intestinal branches,
  - to colon.
    - middle colic,
    - right colic,
    - ileo-colic,
- *Supra-renal.*
- *Renal.*
- *Spermatic*, or *ovarian.*
- *Inferior mesenteric*,
  - left colic,
  - sigmoid,
  - superior hemorrhoidal.
- *Lumbar* (four on each side).
- *Middle Sacral.*

Common Iliac.—The common iliacs are formed by the bifurcation of the aorta at the left of the fourth lumbar vertebra, and hence about one inch below and a little to the left of the umbilicus. Each artery runs downwards and outwards, until at the level of the intervertebral substance, between the last lumbar vertebra and the sacrum, it divides into

Internal iliac, to supply the pelvic organs, etc.
External iliac, to supply most of lower extremity.

Each common iliac is crossed, near its bifurcation into the terminal branches, by the ureter.

INTERNAL ILIAC extends from lumbo-sacral articulation to great sacro-sciatic notch, where it divides into

An anterior trunk,
A posterior trunk.

In the fœtus the internal iliac is called hypogastric, and passes up to the umbilicus, where it leaves the body and goes to the placenta. After birth the portion between the umbilicus and the top of the bladder becomes a fibrous cord (posterior false ligament of the bladder), while the portion between the bladder and anterior trunk of the internal iliac becomes reduced in size and remains as the superior vesical artery.

ANTERIOR TRUNK OF INTERNAL ILIAC.

Superior vesical,
Middle vesical, } to bladder.
Inferior vesical,
Middle hemorrhoidal to rectum.
Obturator passing through obturator foramen to thigh.
Internal pudic passing out by greater, and into pelvis again by lesser sacro-sciatic notch.
    inferior hemorrhoidal,
    perineal, { superficial, transverse.
    branches to genitals, { a. of the bulb, a. of corpus cavernosum, dorsal of penis.
Sciatic.

In the female the anterior trunk of internal iliac gives off uterine and vaginal; and the genital branches of the internal pudic go to the corresponding parts of the vagina and clitoris.

POSTERIOR TRUNK OF INTERNAL ILIAC.

ilio-lumbar,
lateral sacral, { *superior*, *inferior*.

gluteal,
superficial,
deep,
nutrient (to ilium).

EXTERNAL ILIAC.—From its origin, at the bifurcation of the common iliac, it passes along the margin of the Great psoas muscle, to make its exit from the pelvis under the middle of Poupart's ligament. It then becomes the common femoral artery.

Deep epigastric.
Deep circumflex iliac.

The veins accompanying all the iliac arteries, except the right common iliac, lie to the posterior and inner sides of their respective arteries. The right common iliac vein, on the contrary, lies to the outer side of its artery.

COMMON FEMORAL.—Extends from under middle of Poupart's ligament to its bifurcation into superficial and deep femoral. This point is very variable, but is usually one and a half or two inches below Poupart's ligament. The common, and the upper portion of the superficial femoral divide into halves Scarpa's triangle, which is formed by Poupart's ligament for its base, and the Sartorius and the Long adductor for its sides.

Superficial epigastric.
Superficial circumflex iliac.
External pudic, $\left\{\begin{array}{l}\textit{superficial,}\\ \textit{deep.}\end{array}\right.$

Superficial femoral, extends from bifurcation of common femoral to opening in Great adductor, when it becomes the popliteal. The line of common and superficial femorals is from middle of Poupart's ligament to inside of inner condyle.

Muscular,
Great anastomotic.

Deep femoral, (profunda femoris). This trunk arises at the bifurcation of the common femoral and supplies many of the thigh muscles The common and superficial femoral are often described as the superficial femoral; and the deep femoral is then considered a branch of the superficial vessel.

External circumflex.
Internal circumflex (passes through an opening between the Psoas and Pectineus).

Three perforating.
Terminal branch (often called fourth perforating).

Popliteal—Extends from opening in Great adductor to lower edge of Popliteus muscle; then divides into anterior and posterior tibial.

- *Muscular*,
  - superior,
  - inferior or sural.
- *Articular*,
  - superior,
    - 1, external,
    - 2, internal.
  - inferior,
    - 3, external,
    - 4, internal.
  - 5, azygos.

Anterior Tibial.—This artery extends from lower edge of Popliteus muscle to the middle of the ankle joint in front. It, in the upper part of its course, lies on the front of the interosseous ligament, and then comes forward, lying at the outside of the Anterior tibial muscle. It finally becomes the dorsal artery of the foot. Recollect that tibial nerves lie to fibular side of tibial arteries.

- ***Recurrent tibial.***
- ***Muscular.***
- ***Malleolar***,
  - *internal*,
  - *external.*
- *Dorsal of foot*, from middle of ankle to first interosseous space.
  - Tarsal.
  - Metatarsal.
  - Interosseous and digital.
  - Dorsal of great toe (which is really an interosseous coming from main trunk).
  - Communicating.

Posterior Tibial.—From lower border of Popliteus muscle to inner side of calcaneum below the inner malleolus, where it divides into internal and external plantar.

- *Peroneal* (runs along inner border of fibula on posterior part of leg).
- *Anterior peroneal.*
- *Muscular.*
- *Nutrient.*
- *Communicating.*
- *Internal calcanean.*
- *Internal plantar* is smaller than external plantar, and runs along inner border of sole.

External plantar. After getting to outer border of sole it curves towards the great toe, forming the plantar arch, which joins the communicating branches of the dorsal. There is, therefore, only one arch in the foot, and it lies over the bases of the metatarsal bones. In the hand there are two palmar arches.

- Plantar arch.
    - Posterior perforating (anastomosing with interosseous of metatarsal).
    - Digital (arranged very much like digital in palm).
    - Anterior perforating.

PULMONARY ARTERY.

This artery, which carries the *venous* blood from the right heart to the lungs, has already been mentioned in describing the course of the circulation. It leaves the right ventricle at the top, and lies in front of the aorta. It is very large and about two inches long. It divides into the right and left pulmonary arteries, each of which goes to a lung and rapidly divides into small branches.

THE VEINS.

The veins carry blood towards the heart. There are two venous systems: the pulmonary veins, carrying *arterial* blood, from the capillaries in the lungs, to the left auricle, and the systemic veins, returning the venous blood from the various organs and limbs to the right auricle. The portal vein, with its capillaries, called the portal venous system, is an appendage of the systemic circulation, and is located in the abdomen. The capillaries in the digestive organs conduct the blood towards one large trunk which enters the liver. This trunk is the portal vein, and in the liver breaks up into capillaries, which empty their contents into other capillaries. These finally coalesce to form the hepatic veins, which empty into the vena cava.

PULMONARY VEINS.

These are formed from capillaries communicating with the minute divisions of the pulmonary arteries in the walls of the air vesicles of the lungs. They are usually two in number from each lung and empty into the left auricle. They, of course, carry oxygenated or arterial blood. It must be remembered that the lungs have small arteries and veins, belonging to the *systemic* circulation, which nourish the tissues of the lungs. They are called bronchial arteries and veins, and accompany the ramifications of the bronchial tubes.

SYSTEMIC VEINS.

The systemic veins are divided into three classes, superficial, deep, and sinuses.

The superficial lie between the layers of the superficial fascia, and are given names according to their locality, or from mere fancy of the early anatomists.

The deep veins accompany the arteries, usually in the same sheath; and as a rule are called after the arteries, thus the femoral vein follows the course of the femoral artery. There are some exceptions, however, for the carotid artery has the internal jugular vein at its side. These deep veins are therefore called accompanying veins (venæ comites). The large arteries have only one accompanying vein (vena comes), while the smaller arteries have two—one on each side.

Sinuses are venous channels within the skull, formed by a separation of the layers of the dura mater. They are unlike veins in their structure, but serve the same purpose.

In describing the veins it will be well to group them into three classes:—

1. Those of the head, upper extremity and thorax, terminating in the superior vena cava.
2. Those of the abdomen, pelvis and lower extremity, emptying into the inferior vena cava.
3. The cardiac veins, opening directly into the right auricle.

It should be remembered that the veins communicate in all directions by small irregular branches, and that anomalies are frequent.

VEINS OF THE HEAD.

The veins of the exterior of the head are—

Facial,
Temporal,
Internal maxillary,
Temporo-maxillary,
Posterior auricular,
Occipital.

Facial.—The facial, commencing as the frontal vein, runs down the forehead to the root of the nose, where the veins of the two sides are connected by the nasal arch; thence along the inner canthus as the angular; beyond which point it is the facial vein. It crosses the lower jaw just in front of the Masseter muscle, and, after receiving the temporo-maxillary, empties into the internal jugular.

It receives the following branches:—

Supra-orbital,
Nasal,
Superior palpebral,
Inferior palpebral,
Superior labial,
Inferior labial,
Buccal,
Masseteric,
Submental,
Inferior palatine,
Sub-maxillary,
Ranine.

Temporal.—The temporal, commencing at the top of the head, runs down behind the condyle of the jaw and forms, by uniting with the internal maxillary, the temporo-maxillary vein.

It is joined by—

Middle temporal,
Parotid,
Anterior auricular,
Transverse facial.

Internal Maxillary.—The internal maxillary starts in the pterygoid plexus, formed by the junction of the several branches mentioned below, and it then unites with the temporal behind the condyle of the jaw. The branches forming the pterygoid plexus correspond with those from the internal maxillary artery, and are as follows:—

Middle meningeal,
Deep temporal,
Pterygoid,
Masseteric,
Buccal,
Palatine.

Temporo maxillary.—The temporo-maxillary vein passes from the junction of the temporal and internal maxillary downwards into the parotid gland, where it divides into two branches, one joining the facial, the other, the external jugular. It receives only the posterior auricular.

Posterior Auricular.—The posterior auricular, starting upon the side of the head, runs down behind the ear and joins the temporo-maxillary to form the external jugular. It receives—

Stylo-mastoid,
Branches from external ear.

Occipital.—The occipital, commencing just behind the vertex of the head, passes downward with the occipital artery to empty into the internal jugular. It communicates with lateral sinus by the mastoid.

VEINS OF THE NECK.

These are five in number—

External jugular,
Anterior jugular,
Posterior jugular,
Internal jugular,
Vertebral.

External Jugular.—The external jugular is formed by the union of the temporo-maxillary with the posterior auricular in the parotid gland, and passes downwards through the neck to empty into the subclavian. Its direction is that of a line drawn from the angle of the jaw to the middle of the clavicle. The superficial cervical nerve crosses it; and running with it at its upper part is the great auricular nerve. It has two valves, and receives—

Posterior jugular,
Supra-scapular,
Transverse cervical.

Posterior Jugular.—The posterior jugular draws the blood from the upper and back part of the neck, and terminates in the external jugular a little below the middle.

Anterior Jugular.—The anterior jugular carries the blood from the superficial parts in the anterior portion of the neck, and empties into the external jugular. It has no valves.

Internal Jugular.—The internal jugular, commencing at the posterior lacerated foramen, or jugular foramen, where the lateral and inferior petrosal sinuses unite, runs down the neck on the outer side of the internal and common carotid arteries, and joins the subclavian to form the innominate vein. It is accompanied by the pneumogastric nerve, and has only one pair of valves.

Its branches are—

Facial,
Lingual,
Pharyngeal,
Superior thyroid,
Middle thyroid,
Occipital (previously described).

Vertebral.—The vertebral vein collects blood from the occipital portion of the head, and runs down the side of the spinal column to open into the innominate. It does not enter the skull like the vertebral artery, but draws the blood from the exterior of the head and neck, and the interior of the spinal canal. It passes through the foramina in the transverse processes of the upper six, and, sometimes, of all the cervical vertebræ, making a bend outwards, to enter that of the atlas. It has one pair of valves and is joined by the following:—

Posterior condyloid,
Muscular,
Dorsi-spinal,
Meningo-rachidian, from interior of spinal canal,
Ascending cervical,
Deep cervical.

VEINS OF THE DIPLOË.

Diploic Veins.—The diploë of the skull is traversed by a large number of veins running irregularly through it. Four chief trunks have been distinguished: a frontal, running through the supra-orbital notch; an anterior and posterior temporal, one terminating by joining the deep temporal and the other in the lateral sinus; and an occipital, which empties into the occipital vein or the occipital sinus. It is thus evident that there are two veins called occipital.

VEINS OF THE BRAIN.

Cerebral Veins.—The cerebral veins are devoid of muscular tissue and valves. They are superficial and deep.

The superficial run along the fissures between the convolutions and empty into the various sinuses. There are on each side eight superior, emptying into the superior longitudinal sinus; and about eight inferior, called anterior, lateral and median inferior. The anterior empty into the cavernous sinus, the lateral into the lateral sinus, and the median into the straight sinus.

The deep cerebral or ventricular veins, called veins of Galen, are formed by the veins of the corpora striata and the choroid veins, and, running backwards in the velum interpositum, through the transverse fissure, empty into the straight sinus. One comes from each lateral ventricle.

Cerebellar Veins.—The cerebellar veins occur in three sets, superior, inferior and lateral, and empty into the straight, lateral and superior petrosal sinuses, respectively.

The Sinuses of the Dura Mater.—These are fifteen in number, seven upon the upper and back portions of the skull, and eight upon its base. Those of the former set are—

- Superior longitudinal,
- Inferior longitudinal,
- Straight,
- Lateral (2),
- Occipital (2).

Superior Longitudinal.—The superior longitudinal, commencing in the foramen cæcum, extends along the whole of the upper border of the falx cerebri and empties into the torcular Herophili. At the torcular Herophili six sinuses meet, the superior longitudinal, the straight, the two lateral and the two occipital.

Inferior Longitudinal.—The inferior longitudinal sinus is situated in the lower free border of the falx cerebri, and runs backwards to the straight sinus, in which it terminates.

Straight.—The straight sinus is formed at the attachment of the fàlx cerebri to the tentorium cerebelli. It receives the inferior longitudinal sinus and the two veins of Galen.

Lateral.—The lateral sinuses are contained between the attached edges of the tentorium, and curve outwards, then forwards and inwards to the posterior lacerated foramen, where each opens into the internal jugular vein. They receive the superior longitudinal, the straight, the two occipital sinuses.

Occipital.—The occipital, the smallest sinuses, run from the foramen magnum, parallel with each other, backwards and upwards to the torcular Herophili.

The sinuses upon the base of the skull are—

- Cavernous (2),
- Circular,
- Inferior petrosal (2),
- Transverse,
- Superior petrosal (2).

Cavernous.—The cavernous sinuses lie on either side of the sella Turcica, and, commencing at the sphenoidal fissure, run backwards to the apex of the petrous portion of the temporal bone, where they are continuous with the inferior petrosal. They receive the inferior anterior cerebral veins, communicate with the petrosal sinuses, and receive the ophthalmic vein. They are connected with each other by the circular and transverse sinuses.

Circular.—The circular surrounds the pituitary body and communicates with the cavernous sinuses.

Inferior Petrosal.—Each inferior petrosal is placed in a groove between the petrous part of the temporal bone and the basilar process of the occipital, and is the continuation of the cavernous backwards to the jugular foramen. Here it unites with the lateral sinus, and gives origin to the internal jugular vein.

Transverse.—The transverse crosses the basilar process near its anterior end, and connects the two inferior petrosal sinuses together.

Superior Petrosal.—Each superior petrosal runs along the groove in the upper edge of the petrous part of the temporal bone, to the sides of which the tentorium is attached. It connects the cavernous with the lateral sinus and receives the anterior lateral cerebellar, and, occasionally, the inferior lateral cerebral vein.

VEINS OF THE UPPER EXTREMITY.

The superficial veins are—

Anterior ulnar,
Posterior ulnar,
Basilic,
Radial,
Cephalic,
Median,
Median basilic,
Median cephalic.

Anterior Ulnar.—The anterior ulnar, arising from the front of the ulnar side of the hand, runs up the inner side of the forearm to the elbow, where it joins the posterior ulnar and forms the basilic.

Posterior Ulnar.—The posterior ulnar, starting upon the ulnar portion of the back of the hand, ascends upon the posterior surface of the forearm to meet the anterior ulnar and form the basilic vein.

Basilic.—The basilic, formed by the two ulnar veins, pierces the deep fascia and runs up the inner side of the arm, along the brachial artery, to empty into the accompanying veins of the artery, or into the axillary. It receives the median basilic.

Radial.—The radial originates on the surface of the thumb and first finger and radial side of the hand, and passes up the outer side of the forearm to the elbow, where it joins with the median cephalic and forms the cephalic vein.

Cephalic.—The cephalic commences at the bend of the elbow, ascends the arm external to the biceps, and then runs between the Great pectoral and Deltoid muscles, to enter the axillary vein under the clavicle. It sometimes communicates with the external jugular.

Median.—The median returns the blood from the palm of the hand and front of the forearm, extending to the elbow, where it receives a communicating branch from the deeper veins, and terminates in the median cephalic and median basilic veins.

Median Cephalic.—The median cephalic passes upwards and outwards, to make, with the radial, the cephalic vein.

Median Basilic.—The median basilic runs upwards and inwards, to meet the basilic. Branches of the internal cutaneous nerve pass in front of and behind this vein, and it is separated from the brachial artery beneath by the bicipital fascia.

The Deep Veins of the Upper Extremity.

They accompany the corresponding arteries, and are usually two in number, placed one on each side of the artery, and frequently joined by transverse branches. The small veins are not of sufficient importance to justify further description.

Axillary.—The axillary, formed by the continuation of the basilic, curves upwards and inwards, through the lower and front part of the axilla, to lower border of the first rib, where it becomes the subclavian. It receives branches corresponding with those coming from the artery, and lies to the inner side of that vessel.

Subclavian.—The subclavian commences where the axillary ends, at the outer border of the first rib, and terminates behind the sterno-clavicular articulation by joining the internal jugular. The two thus form the innominate vein. The subclavian vein lies in front of the artery and Anterior scalene muscle, and is joined by the external and anterior jugular veins.

Right Innominate.—The right innominate, about one inch and a half long, extends from the sterno-clavicular articulation to a point behind the lower border of the first costal cartilage, where it unites with the left innominate and forms the superior vena cava. It lies internal to and more superficial than the innominate artery. Its branches, all of the right side, are—

Vertebral,
Internal mammary,
Inferior thyroid,
Superior intercostal.

It also receives the right lymphatic duct.

Left Innominate.—The left innominate, larger than the right and about twice as long, commences behind the inner end of the clavicle and runs transversely across the chest in front of the large branches of the aorta, to meet the vein of the right side and give rise to the superior vena cava. It receives the same branches from the left, as the right innominate does from the right side of the body. On this side of the body the lymphatic duct (thoracic duct) opens into the subclavian vein. The innominate veins have no valves.

Internal Mammary.—The internal mammary veins, placed one on each side of the artery, unite and empty into the innominate.

Inferior Thyroid.—The inferior thyroid veins, often three or four in number, commence in the plexus of veins about the thyroid body and descend the neck, near the middle line, to the innominate vein.

Superior Intercostal.—The superior intercostal veins accompany the artery and return the blood from the upper two or three intercostal spaces. They terminate in the innominate veins, and that of the left side receives the left bronchial vein.

Superior Vena Cava.—The superior vena cava, between two and three inches in length, is formed by the union of the two innominate veins and returns to the heart all the blood from the upper portion of the body. From the lower border of the first costal cartilage of the right side it passes directly downwards to the right auricle. It is joined by the great azygos vein and several pericardial veins. It has no valves.

The three azygos veins connect the two venæ cavæ and take the place, as it were, of these vessels in the region where the heart is located.

Great Azygos Vein.—The right, or great, azygos vein is formed by a branch from the lumbar veins on a level with the first or second lumbar vertebra, whence it ascends along the right side of the spinal column, and passes through the diaphragm, with the aorta and thoracic duct, to the third dorsal vertebra, opposite which it enters the superior vena cava.

Its branches are as follows:—

Intercostal (lower ten of right side),
Smaller azygos,
Œsophageal,
Mediastinal,
Vertebral,
Right bronchial.

Smaller Azygos.—The left, lower, or smaller azygos vein originates in the renal or left lumbar veins, and, piercing the left crus of the diaphragm, rises to the sixth or seventh dorsal vertebra, where it turns obliquely to the right and enters the great azygos vein. It receives the lower intercostal and some œsophageal and mediastinal veins.

Left Upper Azygos (*smallest*).—The left upper, or smallest, azygos vein collects the blood from the two or three spaces not drained by the superior intercostal or the smaller azygos. It terminates in the great or lesser azygos vein.

Bronchial.—The bronchial veins originate in the lung substance. The one on the right side empties into the great azygos; that on the left terminates in the super-intercostal vein.

THE SPINAL VEINS.

There are four sets of spinal venous plexuses—

1. Outside the spinal column (dorsi-spinal).
2. Between the vertebræ and the membranes of the cord (meningo-rachidian).
3. In the bodies of the vertebræ.
4. In the membranes of the cord (medulli-spinal).

1. *The dorsi spinal* veins originate in the muscles and integument behind the spinal column, and, after communicating with the veins of the adjacent vertebræ, empty into the vertebral, the intercostal, the lumbar or the sacral, according to the regions they occupy.

2. *The anterior and posterior longitudinal* spinal veins extend through the spinal canal, lying upon its anterior and posterior walls. They connect the dorsi-spinal veins and join the vertebral, intercostal, lumbar and sacral veins.

3. *The veins of the bodies of the vertebræ* arise in the substance of the bodies and converge to form one trunk,

which escapes backwards into the anterior longitudinal spinal veins.

4. *The veins of the spinal cord*, or the medulli-spinal veins, extend over the surface of the cord between the pia mater and the arachnoid. At the intervertebral foramina they terminate in the other veins from the canal.

THE VEINS OF THE LOWER EXTREMITY.

The veins of the lower limb are arranged, as those of the upper, in a superficial and a deep set. The latter follow the course of the arteries and constitute their accompanying veins, or venæ comites.

The superficial veins are—

Internal, or Long saphenous.
External, or Short saphenous.

Internal Saphenous.—The internal saphenous commences upon the dorsum and inner side of the foot, runs in front of the inner malleolus and behind the inner condyle to the saphenous opening. In the leg, it lies behind the inner border of the tibia with the internal saphenous nerve; in the thigh it ascends towards the saphenous opening, pierces the cribriform fascia and empties into the femoral vein about an inch and a half below Poupart's ligament.

Its chief branches are—

Superficial epigastric,
Superficial circumflex iliac.
Superficial external pudic.

External Saphenous.—The external saphenous vein originates upon the upper and outer sides of the foot and passes behind the outer ankle. It ascends the leg with the external saphenous nerve, first along the outer side of the tendon of Achilles, and then up the middle of the posterior surface to the popliteal space, where it opens into the popliteal vein.

The Deep Veins of the Lower Extremity.

Plantar.—The external and internal plantar veins follow the corresponding arteries, and unite to form the accompanying veins of the posterior tibial artery.

Posterior Tibial.—The posterior tibial veins pass up the leg with the artery, receive the peroneal veins, and join the anterior tibial to form the popliteal.

Dorsal of Foot.—The dorsal veins accompany the dorsal artery of the foot.

Anterior Tibial.—The anterior tibial are continuations of those with the dorsal artery of the foot. In the upper portion of the leg they pass backwards and meet the posterior tibial, giving rise to the popliteal vein.

Popliteal.—The popliteal, formed by the union of the anterior and posterior tibial veins, passes upwards through the popliteal space to the opening in the Great adductor, beyond which it is called the superficial femoral. It lies internal to the artery below, but soon crosses it and becomes external above. It receives branches corresponding to those of the popliteal artery.

Superficial Femoral.—The superficial femoral vein is the continuation of the popliteal, and ascends the thigh to the point below Poupart's ligament, where the deep femoral joins it. It follows the artery, lying external to it below, but finally getting behind it.

Deep Femoral.—The deep femoral joins the superficial femoral to form the common femoral.

Common Femoral.—This vein is formed by the deep femoral and the superficial femoral, and lies to the inner side of the common femoral artery. It terminates under Poupart's ligament in the external iliac vein. Between it and Gimbernat's ligament is the internal femoral ring. The femoral veins receive branches corresponding to those given off by the arteries of the same name.

External Iliac.—The external iliac extends from Poupart's ligament upwards and inwards, to a point opposite the sacro-iliac symphysis, where it joins the internal iliac and makes the common iliac vein. On the right side it lies first internal to, and then beneath, the artery. On the left side the vein is internal throughout. Its branches are the superficial and deep epigastric and circumflex iliac veins. It has no valves.

Internal Iliac.—The internal iliac is formed by the coalescence of the venæ comites of the branches of the internal iliac artery. It lies at first inside the artery and then behind it. The blood is, therefore, returned by these venous branches from within and without the pelvis.

Common Iliac.—The common iliac, formed by the junction of the external and internal iliac veins, extends from the sacro-iliac symphysis to the level of the intervertebral cartilage between the fourth and fifth lumbar vertebræ, where the two common iliacs form the inferior vena cava. On the right side, the vein ascends in an almost vertie direction, while on the left it crosses more obliquely towards the right, and is longer. All the iliac veins lie to the inner side of the corresponding arteries, excepting the common iliac of the right side, which is partially external to the accompanying artery. The common iliac veins receive the ilio-lumbar, and sometimes the lateral sacral veins. The middle sacral generally terminates in the left common iliac.

Inferior Vena Cava. The inferior vena cava collects the blood from all that portion of the body below the diaphragm. Commencing at the right of the cartilage between the fourth and fifth lumbar vertebræ, where the common iliacs unite, the vena cava ascends in front of the spinal column and to the right of the aorta. It pierces the tendon of the diaphragm and opens into the right auricle. The inferior vena cava receives the following veins:—

Lumbar,
Right spermatic (left goes to left renal),
Ovarian (in the female),
Renal,
Right supra-renal (left emptying into renal),
Right inferior phrenic (left going to renal),
Hepatic (formed from intra-lobular by sub-lobular veins).

These branches require little description, as they correspond closely with the arteries. These phrenic veins are called inferior, because there are superior phrenic veins on the upper surface of the diaphragm accompanying the phrenic nerve.

The relative position of the large veins of the trunk may be recollected by the general rule that those above the diaphragm lie in front of their arteries, while those below it, except the renal, lie behind.

THE PORTAL SYSTEM.

The portal system of veins comprises:—

Inferior mesenteric,
Superior mesenteric,
Splenic,
Gastric,

which collect the blood from the digestive organs and the spleen and carry it to the liver.

Mesenterics.—The inferior and superior mesenteric veins collect the blood from the intestines by means of branches corresponding to those of the mesenteric arteries. They accompany those arteries, and the superior, after receiving the right gastro-epiploic vein, joins the splenic to make the portal; while the inferior terminates in the splenic vein.

Splenic.—The splenic, commencing in the substance of the spleen, runs horizontally inwards to form, with the superior mesenteric, the portal vein. It receives

Vasa brævia, Pancreatic,
Left gastro-epiploic, Pancreatico-duodenal,
and Inferior mesenteric.

Portal Vein.—The portal vein (vena portæ, not vena porta), formed by the union of the superior mesenteric and splenic veins, ascends through the lesser omentum behind the hepatic artery and duct to the liver, which it enters by the transverse fissure. It is about four inches long, and divides, first, into two branches. These further subdivide, following the ramifications of the artery and duct, to become the inter-lobular veins. Besides a small branch, the cystic, it receives the gastric vein.

Gastric.—The gastric runs, with the gastric artery, upon the lesser curvature of the stomach from left to right to join the portal vein.

The formation of the portal vein will be understood by this table :—

Middle colic, Right colic, Ileo-colic, Small intestinal, Right gastro-epiploic,	*superior mesenteric.*	PORTAL VEIN, branches, gastric, cystic.
Inferior mesenteric, Vasa brevia, Left gastro-epiploic, Pancreatic, Pancreatico-duodenal,	*splenic.*	

CARDIAC VEINS.

These are—

Great cardiac, Anterior cardiac,
Posterior cardiac, Veins of Thebesius,

The great cardiac runs in the anterior interventricular groove from the apex to the base of the ventricles, where it curves around in the auriculo-ventricular groove to the back of the heart and becomes the coronary sinus. It has valves at its opening into this sinus.

The posterior cardiac also commences at the apex but ascends along the posterior interventricular groove and terminates in the coronary sinus.

The anterior cardiac veins, three or four in number, extend from the surface of the right ventricle and open into the right auricle.

The Veins of Thebesius, are a number of small vessels, returning the blood from the substance of the heart and emptying separately into the right auricle.

The Coronary Sinus is the continuation of the great cardiac vein, and lies in the posterior portion of the left auriculo-ventricular groove. It is about an inch long, and enters the right auricle, being furnished by a fold of endocardium called the coronary valve. It receives the great cardiac, posterior cardiac, and some smaller veins.

THE LYMPHATICS, OR ABSORBENTS.

The lymphatic system includes the lymphatic glands and the lymphatic and lacteal vessels. The lacteals are the lymphatic vessels of the small intestine, and carry not only lymph, but the chyle, which gives them a white color. The other lymphatics carry lymph only. The lymphatic vessels are delicate, transparent tubes, furnished with valves like the veins. They have been found in nearly every structure, but their presence has not been proved in bone, cartilage, tendon, nor in the brain and spinal cord substance. They are arranged in superficial and deep groups; and begin as plexuses, which empty into larger vessels, and these into still larger, until the largest lymphatic ducts open into the venous system by the subclavian veins. The lymphatic glands are situated in the course of the lymphatic vessels, especially in the neck, axilla, groin, mesentery, along the great vessels of the abdomen, and in the mediastinal spaces. The larger vessel, before entering a gland, breaks up into little branches, called afferent vessels; these form a plexus within the gland, and then combining together, make their exit as a few efferent vessels, which finally coalesce to make a larger trunk.

The lymph and chyle are conveyed into the blood current by the right and left lymphatic ducts. The left is much the larger, and is usually called the thoracic duct. It carries the chyle, and the lymph from the greater part of the organism.

Thoracic Duct.—This is the great channel for the chyle, and for the lymph from every part of the body, except the right arm, right side of head, neck, and chest, and upper surface of liver. The right lung, and right side of the heart are included in the lymphatic distribution of the right side, but the left lung and left side of the heart have lymphatics terminating in the thoracic duct. The thoracic duct begins in the receptacle for chyle (receptaculum chyli), which lies in front of the second lumbar vertebra, to the right of, and behind the aorta. The duct goes up through the aortic opening in the diaphragm, continues in front of the spine in the posterior mediastinum, and at the level of the fourth dorsal vertebra inclines to the left of the column, keeping behind the aorta. It continues to ascend until, at the upper edge of the seventh cervical, it curves forwards and downwards, and, passing in front of the Anterior scalene muscle, discharges its contents into the subclavian vein at its angle of junction with the internal jugular. It has valves throughout its course, especially at the upper part. It receives the lymphatic trunks coming from all parts of the body and limbs, with the exceptions mentioned above.

Right Lymphatic Duct.—This is only an inch long, and, after receiving the vessels from the right arm, the right side of head, neck and chest, and the upper surface of the liver, empties into the right subclavian at its union with the internal jugular. Its orifice is guarded by valves also, to prevent regurgitation of blood from the vein.

Lymphatic Glands and Small Vessels.—These are named from the regions in which they are located, and do not need detailed description. Thus we have, occipital, posterior auricular, submaxillary, cervical, mediastinal, axillary, sacral and lumbar lymphatic glands; and lymphatic vessels corresponding.

CHAPTER V.

THE NERVOUS SYSTEM.

The nervous system comprises the cerebro-spinal system and the sympathetic system. The former is often called the system of animal life, because it presides especially over the functions of locomotion, volition, sensation, etc.; the latter that of organic life, since the functions of nutrition and growth seem to be under its sway. Each of these systems is made up of ganglia and nerves, which are composed of the three varieties of nervous tissue.

The principal part of the nervous system consists of the two forms of structure called the gray or vesicular, and the white or fibrous. The gray nervous tissue is supposed to be that in which the nervous impulses and impressions originate, while the white acts as a conductor for such impulses and impressions. This may be illustrated by calling the gray or vesicular matter the galvanic battery; the white or fibrous portion, the telegraph wires. There is, however, a third form of nervous matter, found especially in the sympathetic system and in the olfactory nerve, which is called the gelatinous (fibres of Remak). As there is still a difference of opinion as to the true nature of this tissue, it is less important than the two forms mentioned above.

The gray, or vesicular, nervous tissue is found in the middle of the spinal cord, the surface of the brain and in the ganglia, but not in the nerves. It consists of corpuscles, or vesicles of various forms, containing nuclei and nucleoli. The white or fibrous tissue is found in the exterior of the cord, the interior of the brain, in the nerves, and in a great part of the sympathetic system. It is composed of a series of tubes, each of which has an axis-cylinder, surrounded by the white substance of Schwann, and enclosed in the tubular membrane. The white substance is supposed to be fluid fat, and serves to protect the axis cylinder, which is the true conductor. It will be seen that the axis cylinder resembles the delicate telegraph wire of copper enclosed in rubber insulating material, and surrounded by a protecting sheath. Many of these tubes placed side by side form a bundle, and these bundles are placed together to form larger or smaller nerves. The investment around the bundles is called the neurilemma, or perineurium. The completed nerves themselves have also a sheath. As a nerve runs to a ganglion, or towards a single cell or vesicle, it splits up into its ultimate nerve tubules, and these lose their white substance and probably join the cell as simple axis-cylinders.

It is necessary that the nervous tissue be held together whenever it is massed, as in the brain and cord; hence, it is supported and joined by a network of connective tissue, called the neuroglia, or "nerve glue."

The ganglia, found throughout various parts of the nervous system, are independent nerve centres, similar to, but much less complex than the brain. They consist of gray substance traversed by nerve fibres, either tubular or gelatinous.

A plexus is a communication between several nerves, where their branches, by joining and separating, have their fibres intermingled. A sensory, centripetal, or afferent nerve transmits nervous impressions from the peripheral end towards a centre, such as the brain. A motor, centrifugal, or efferent nerve transmits impulses from the centre towards the parts to which the nerve is distributed, and thus causes motion, secretion, etc.

Sensory nerves terminate as minute plexuses, as end bulbs of Krause, tactile corpuscles of Wagner, and Pacinian corpuscles. In special organs their terminations are more complex and still less perfectly understood. Motor nerves terminate in muscles as plexuses, or in motorial end-plates. The central termination of nerves has not been made out, though it seems probable that the axis cylinders terminate in vesicles of the gray matter.

THE CEREBRO-SPINAL SYSTEM.

This system, called also the nervous system of animal life, consists of, 1, the brain and spinal cord, termed the cerebro-spinal centre or axis; 2, the ganglia, situated upon some of the nerves; and 3, the nerves.

THE SPINAL CORD AND MEMBRANES.

We shall consider the cord and its membranes before the brain, because it is much more readily understood. The cord, surrounded by its membranes, lies in the spinal canal formed by the vertebræ and their ligaments. The membranes are: 1, the outer or dura mater, a fibrous structure; 2, the middle or arachnoid, which is serous tissue; and 3, the inner or pia mater, which is a vascular membrane. The relative position of these coverings may be recollected by the word PAD, the first letter signifying the internal membrane.

Dura Mater.—This covering extends from the foramen magnum of the occipital bone, to the edge of which it is fastened, to the coccyx, where it, after becoming a mere cord, is attached to the periosteum on the back of this bone. It is continuous with the dura mater of the brain, and forms sheaths for the spinal nerves. It differs from the similar covering of the brain, because it does not serve as an internal periosteum, nor form sinuses or partitions.

Arachnoid.—This is a serous sac, having a parietal layer, lining the inner surface of the dura mater, and a visceral layer, covering the pia mater and the cord. This is, to my mind, the simpler method of describing the structure, though some believe that there is really no parietal layer next to the dura mater, but state that the inner surface of the dura mater is merely covered by a layer of epithelium. Between the arachnoid and the pia mater is the sub-arachnoid space; the arachnoid cavity is between the two layers of arachnoid.

Pia Mater.—This is chiefly a vascular covering, and is closely attached to the surface of the cord, sending delicate processes into the anterior and posterior fissures. At the lower end of the cord the pia mater is continued downwards, as a narrow thread. This is called the terminal filament (filum terminale), and joins the dura mater. On each side of the cord, between the anterior and posterior roots of spinal nerves, extends a serrated band, which stretches from the pia mater to the dura mater, thus uniting the two layers of arachnoid at each point of serration. This is called the dentated ligament, or lateral ligament, of the cord, while the terminal filament spoken of is the central ligament. These maintain the cord in position as it floats in the sub-arachnoid fluid.

SPINAL CORD.

The spinal cord, or marrow, is about sixteen inches long, and weighs one and a half ounces; it does not fit the canal tightly, and only extends through two-thirds of the length of the bony canal. It floats in the sub-arachnoid fluid and moves up and down, during flexion and extension of the back. The cord proper terminates at the lower edge of the first lumbar vertebra; it presents an enlargement where the nerves forming the brachial plexus are given off, and another at the origin of the lumbar and sacral plexuses. The nerves going to these two plexuses are contained in the spinal canal, before reaching their respective intervertebral foramina, and constitute the so-called horse-tail (cauda equina).

The structure of the cord is seen by a transverse section, which shows that the white matter constitutes the exterior and the gray matter the interior of the organ. The gray matter, in a transverse section, has somewhat the appearance of a letter *H* with crescentic sides, and with the posterior arms longer and more narrow than the anterior arms. The horns of gray matter and the connecting band, or gray commissure, differ, relatively, in shape in different regions of the cord.

Fissures.—The anterior median fissure runs down the front, and the posterior median fissure down the back of the cord. The lateral halves so formed are divided into anterior, lateral and posterior columns by two grooves, from which the anterior and posterior roots of spinal nerves arise. These fissures are called right and left antero-lateral, and right and left postero-lateral fissures. On each side of the posterior median fissure there is a small groove, without special name, which gives rise to the existence of the small posterior median column, really a part of the posterior column.

Columns.—The columns, then, are: 1, the anterior, which is continuous with the anterior pyramid of the medulla oblongata; 2, the lateral, continuous with the lateral tract and olivary body of the medulla oblongata; 3, the posterior, continuous with the restiform body; and 4, the posterior median column becoming the posterior pyramid of the medulla oblongata. The anterior and lateral columns are sometimes denominated together the antero-lateral column, because the line of division is very indistinct.

Canal, or Ventricle, of the Cord.—In the fœtus, until the sixth month, and sometimes in adults, there is seen a central canal extending the whole length of the cord. This is continuous with the fourth ventricle of the brain, and is called the canal of Stilling or the ventricle of the cord. Its remains can always be seen at the top of the cord.

THE BRAIN AND ITS MEMBRANES.

The membranes of the brain are similar in name and structure to those of the cord.

Dura Mater.—The dura mater of the brain, however, forms the internal periosteum of the cranial bones, separates its layers to form the sinuses described under the venous system, and is reflected to form certain partitions between various portions of the brain. It is a fibrous membrane, and has upon its surfaces near the superior longitudinal sinuses the Pacchionian bodies, which are rare in infancy, and whose function is unknown. The processes, or partitions, formed by the dura mater are: the *falx cerebri*, between the two hemispheres of the brain; the *tentorium cerebelli*, which is horizontal and lies between the cerebrum and cerebellum; and the *falx cerebelli*, reaching vertically from the lower surface of the tentorium to the foramen magnum, and thus separating the two hemispheres of the cerebellum.

Arachnoid.—This is the middle or serous covering, and has a visceral and a parietal layer. Where it stretches across the base of the brain, between the middle lobes and in front of the pons Varolii, the visceral layer has beneath it the anterior sub-arachnoid space. Where it extends from the cerebellum to the medulla oblongata is found the posterior sub-arachnoid space.

Pia Mater.—The pia mater contains the small vessels, and covers and dips between the convolutions. It gives off through the transverse fissure of the brain a process, which enters the interior of the brain and becomes the velum interpositum.

THE BRAIN.

The brain, or encephalon, consists of the cerebrum, which is nearly seven-eighths of the whole, the cerebellum, the medulla oblongata, and the pons Varolii. The weight of the male brain is fifty ounces, of the female forty-five ounces avoirdupois.

As the spinal cord has been described already, it will be well to discuss first the medulla oblongata, which is the continuation of the cord, and resembles it in its general anatomy.

THE MEDULLA OBLONGATA OR BULB.

The shape of this portion of the brain is pyramidal, with its base upwards. Its length is one and a quarter inches. It lies upon the basilar process of the occipital bone, extending from the pons Varolii down to the foramen magnum. It has an anterior median fissure like the spinal cord; and at the upper part of the fissure the decussation, or crossing, of the fibres of the two sides is seen. The posterior median fissure gradually widens and reveals the flow of the fourth ventricle of the brain. The surface is divided on each side into the anterior pyramid, lateral tract and olivary body, restiform body, and posterior pyramid.

The anterior pyramid, is a continuation upwards of the anterior column of the cord, and lies between the anterior median fissure and the olivary body. Its inner fibres and the deep fibres of the lateral columns of the cord are seen to decussate with those of the opposite pyramid.

The lateral tract below is wide and corresponds with the lateral column of the cord, but above it becomes narrowed by the insertion of the olivary body between it and the anterior pyramid. The *olivary body* is an oval projection, half an inch in length, lying between the parts just mentioned. On section it is found to be a ganglionic mass, containing a nucleus called the dentate body.

The restiform or "rope-shaped" *body* is continuous with the posterior column of the cord. In the upper part of the medulla oblongata the two restiform bodies diverge, and enter the cerebellum, receiving the name inferior peduncles of the cerebellum.

The posterior pyramid corresponds with the small portion of the spinal cord called the posterior median column. It consists entirely of white fibres. The two diverge to form the lower angle (calamus scriptorius) of the fourth ventricle.

The posterior surface of the medulla oblongata forms a portion of the floor of the fourth ventricle, as will be understood when it is said that this ventricle lies above the medulla oblongata and below the cerebellum. The gray matter seen in the floor of this cavity is continuous with the gray matter of the cord. At the lower angle is seen the opening into the cord, called the canal of Stilling, the ventricle of Arantius, or, best of all, the ventricle of the cord.

The course of the fibres of the medulla oblongata is complicated, and not completely made out by physiologists, though some points are now well established.

THE PONS VAROLII.

This body is aptly termed the bridge of Varolius, for it joins the cerebellum, cerebrum and medulla oblongata together. It lies in front of, and between the two halves of the cerebellum, and is about an inch and a half from side to side. Its fibres on the surface run transversely, and thus it resembles a bridge from one hemisphere of the cerebellum to the other. Its connection with the cerebellum forms on each side the middle peduncle of the cerebellum. Its anterior surface is grooved for the basilar artery; its posterior forms the floor of the upper part of the fourth ventricle. It consists of layers of transverse and longitudinal fibres and an intermingling of gray matter. The former connect the two halves of the cerebellum; the latter are continued up from the spinal cord and medulla oblongata, principally to the cerebrum.

THE CEREBRUM.

This, the largest portion of the brain, is formed of two lateral halves or hemispheres, separated by the longitudinal fissure, in which the falx cerebri is situated. In front the separation is complete, but behind the hemispheres are united at the bottom of the fissure by the white corpus callosum.

Unfortunately the topography of the cerebrum, and indeed of the whole encephalon, is burdened with many difficult Latin names. It is impossible to use the English synonyms, because they would be so unlike the Latin and so unfamiliar that it would only increase the confusion. I shall endeavor to elucidate the subject by employing as few Latin names as possible, and by omitting all mention of unimportant localities, even though they have long titles.

The surface, or cortical substance, of the cerebrum consists of gray matter, and is marked by deep, irregular furrows, dividing it into convolutions. These furrows are more readily traced when the pia mater has been carefully removed. The convolutions (or gyri) and the fissures (or sulci) greatly increase the gray surface of the brain, and are more marked in the higher animals than in the lower, and in the adult than in the child.

There are five lobes of the cerebrum: 1, the frontal, 2, parietal, and 3, occipital, named after the overlying cranial bones; 4, the tempōro-sphenoidal, below the horizontal branch of the fissure of Sylvius and lying in the depression made by temporal and sphenoid bones; and 5, the triangular island of Reil, lying at the bifurcation of the fissure of Sylvius and covered by the overhanging frontal and temporo-sphenoidal lobes.

These lobes are divided by various fissures into the convolutions above mentioned, and there is a general resemblance in regard to the outlines of the convolutions in all human brains. Hence many of the fissures and convolutions have been named. The most constant and important should be learned.

Fissures.—The longitudinal fissure on the convexity divides the cerebrum into two lateral hemispheres and receives the falx cerebri. The fissure of Sylvius, lying at the base, separates the frontal and parietal lobes, and soon divides into an ascending and a horizontal branch. It thus forms also the division, more or less distinct, between the parietal and temporo-sphenoidal lobes. The fissure of Rolando runs downwards from the longitudinal fissure towards the posterior part of the Sylvian fissure, and separates the frontal and parietal lobes at their upper part. The line of division between the parietal and occipital lobes is the parieto-occipital fissure, sometimes better marked on the inner surface of the hemisphere than on its convexity. On the inner surface is seen the calloso-marginal fissure, just above the convolution over the corpus callosum; the ends of the fissure of Rolando and of the parieto-occipital fissure; and a horizontal fissure joining the last, called the calcarine fissure.

Convolutions.—On the upper and outer, or convex surface, we have the convolution of the longitudinal fissure, running along the edge of the fissure and curving over the front and back of the hemisphere to the base of the cerebrum. In front of the fissure of Rolando is situated the ascending frontal convolution and behind it the ascending parietal convolution. These are the most important to remember, because the names superior, middle and inferior frontal, superior, middle and inferior occipital, superior and inferior parietal, superior, middle and inferior temporo-sphenoidal are sufficiently explanatory.

The island of Reil, a triangular portion, often called the fifth lobe, lies in the bifurcation of the fissure of Sylvius, and consists of a half dozen convolutions, called "covered convolutions" (gyri operti), because overhung by the adjacent lobes.

On the inner or flat surface of the hemisphere is seen the convolution of the corpus callosum, lying over the corpus callosum and following its curvature. It is frequently called the gyrus fornicatus. Above it runs the calloso-marginal fissure. On this same surface, between the end of the fissure of Rolando and the parieto-occipital fissure, is the square or quadrate convolution, and between the parieto-occipital and the calcarine fissures, the wedge or cuneate convolution.

THE BASE OF THE CEREBRUM.

The under surface of the cerebrum shows the end of the longitudinal fissure separating the right and left frontal lobes, the fissure of Sylvius on each side, separating the frontal from the temporo-sphenoidal lobe, and the flattened occipital lobes. The base of the brain is usually studied with the pons, medulla oblongata and cerebellum attached to the cerebrum, as a better idea of the relation of parts and of the origin of nerves is thus obtained. The vessels and membranes should be carefully removed, in order to see the parts to be described. The arterial circle of Willis has been fully discussed under the arteries. The prominent points at the base of the cerebrum are placed in the following list. I begin anteriorly and go back to the pons Varolii, already described, but omit the cranial nerves, to be discussed later:—

Olfactory bulbs,
Corpus callosum,
Lamina cinerea,
Anterior perforated spaces,
Optic commissure,
Tuber cinereum,
Infundibulum,
Pituitary body,
Corpora albicantia,
Posterior perforated space,
Crura cerebri.

Olfactory Bulbs.—These are oval bodies attached to the anterior part of the olfactory nerves, and lie one on each side of the longitudinal fissure, making depressions in the frontal lobes.

Corpus Callosum.—The corpus callosum is seen curving around from the upper portion of the longitudinal fissure, as soon as the frontal lobes are separated. It is a white body and terminates at the lamina cinerea. Its bent portion is called the genu or knee. It has on each side a band running towards the fissure of Sylvius called a peduncle.

Lamina Cinerea.—This is a layer of gray matter forming the anterior part of the floor of the third ventricle, and extending backwards from the corpus callosum to the tuber cinereum. It is partly hidden by the optic commissure.

Anterior Perforated Spaces.—The small vessels to the corpora striata, in the interior of the cerebrum, pass through a layer of gray matter at the beginning of the fissure of Sylvius, and behind the roots of the olfactory nerve. These spaces are called anterior perforated spaces.

Optic Commissure.—The two optic nerves join together like the two parts of a letter X. The point of crossing is called the optic commissure; the parts behind, the optic tracts; the portions in front, the optic nerves. The commissure is situated over the lamina cinerea, when the brain lies upside down for examination.

Tuber Cinereum.—This eminence of gray matter is situated behind the optic commissure, and forms part of the floor of the third ventricle. From it extends a funnel-shaped process, *the infundibulum*, which is attached to the pituitary body. The cavity or canal of the infundibulum communicates with the third ventricle. The infundibulum and pituitary body are often torn away in removing the brain from the skull, and the tuber cinereum alone remains.

The pituitary body is a gray vascular mass of two lobes lying in the sella Turcica, where it is held by the dura mater stretched across from the clinoid processes. It resembles in structure the ductless glands, and is attached to the base of the cerebrum by the infundibulum.

The corpora albicantia (singular, a corpus albicans) are two white nodules lying behind the tuber cinereum and between the crura cerebri. They are really the lower ends of the anterior crura of the fornix, which bend and then pass upwards to the optic thalami. A better name for them is the bulbs of the fornix.

Posterior Perforated Space.—This space lies between the crura cerebri and behind the corpora albicantia, and admits the vessels going to the optic thalami. There is only one posterior, though there are two anterior perforated spaces.

Crura Cerebri.—These peduncles of the cerebrum are two thick bundles of fibres extending from under the edge of the pons to the optic thalami. They diverge as they leave the pons, and leave the interpeduncular space in which lie the tuber cinereum, corpora albicantia and posterior perforated space, already described. They are crossed by the optic tracts, and contain a gray nucleus called the locus niger. They consist of the fibres of the cord and medulla oblongata, continuing upwards to the cerebrum.

THE INTERIOR OF THE CEREBRUM.

The general structure of the cerebrum will be understood by this description: The two peduncles diverge, enter the cerebrum, and pass to the great ganglia of the brain, of which there are two in each hemisphere. The anterior is the striated body (corpus striatum), the posterior the optic bed (thalamus opticus). In a general way it may be said that the motor fibres of the cord and peduncle come from the striated body, the sensory fibres go to the optic thalamus. The two hemispheres of the cerebrum are joined by the corpus callosum, which is composed of transverse fibres and acts like a bridge. This stretches from side to side above the great ganglia. The cavity left below the corpus callosum and between the peduncles and ganglia of the two sides is the ventricular cavity. The upper part of this is divided into two lateral ventricles by the septum lucidum; under these lies the third ventricle, separated from them by the fornix and velum interpositum, but communicating with them by the foramen of Monro. There is a small canal running from this third ventricle backwards to the fourth ventricle, previously stated as being above the medulla oblongata and below the cerebellum. This is the aqueduct of Sylvius. Within the septum lucidum is a small cavity called the fifth ventricle.

DETAILS OF THE INTERIOR OF THE CEREBRUM.

If the upper part of the hemispheres be removed with a scalpel, the white matter of the interior presents an oval surface, surrounded in each hemisphere by a border of gray matter. These are called the lesser oval centres. Between them is the remains of the longitudinal fissure, at the bottom of which lies the corpus callosum. The space between the top of the corpus callosum and the overhanging convolutions is sometimes called the ventricle of the corpus callosum. The name, however, tends to cause confusion and should be discarded. If the section is made on a level with the corpus callosum, the oval surface formed by the white matter of the two hemispheres and joined by the corpus callosum is called the greater oval centre. In the white matter so exhibited are numerous red points, caused by the incision dividing small vessels.

The corpus callosum, the anterior end of which was seen at the base of the brain, is exposed by the last section. It is four inches in length, and in front curves around to the base of the brain. Its fibres run transversely and unite the two hemispheres. Its posterior end is attached to the fornix which lies underneath. Upon its upper surface are seen the median raphe and longitudinal striations. The innermost of these striations are improperly called nerves of Lancisi.

The Lateral Ventricles.—These cavities are shown by cutting through the corpus callosum and the white substance at its margins. They are lined by serous membranes, and each one has a central cavity and three prolongations, or horns. The anterior horn, or cornu, runs forwards into the anterior lobe of the cerebrum, the posterior into the posterior lobe, the middle or descending downwards into the middle lobe. The ventricles are separated from each other by the septum lucidum, which is a vertical partition extending from the corpus callosum down to the fornix. The roof of each lateral ventricle is formed by the corpus callosum; the floor is made up of a number of structures, which I shall enumerate by beginning in front. They are the corpus striatum and optic thalamus, with the tænia semicircularis between them, the choroid plexus, corpus fimbriatum, fornix, and major and minor hippocampi.

Corpus Striatum.—This large motor ganglion is so called because a section shows it to consist of white and gray matter giving a striated appearance. It is an oval mass and lies partly in the floor of the lateral ventricle and partly imbedded in the white matter of the cerebrum.

Tænia Semicircularis.—This narrow band lies in the groove between the corpus striatum and the optic thalamus.

The optic thalamus is the large sensory ganglion of the brain, and lies behind and to the inner side of the striated body. It forms the lateral boundary of the third ventricle, to be described hereafter, and lies upon the crus cerebri of the corresponding side of the brain. On its posterior and inferior portion are situated the geniculate bodies.

The choroid plexus is a vascular membrane which emerges from under the edge of the fornix and can be seen descending into the middle horn. It is the margin of the velum interpositum, which lies under the fornix and which is a portion of pia mater from the exterior of the brain. This process of pia mater enters the interior of the cerebrum through the transverse fissure, which is above the cerebellum. The choroid plexus of one side joins with that of the other through the foramen of Monro, which connects the two lateral ventricles and is situated behind the anterior peduncles of the fornix.

The corpus fimbriatum is a name given to the edge of the fornix overlying the choroid plexus.

Fornix.—This triangular structure lies under the corpus callosum; behind they are continuous, but anteriorly they diverge from each other, on account of the fornix curving downwards. The vertical partition called the septum lucidum is placed between their anterior portions. The fornix in front divides into two crura or peduncles, which pass to the base of the brain and form the corpora albicantia. The fornix posteriorly is continuous with the lesser hippocampus, an elevation lying in the posterior horn of the ventricle; and laterally with the greater hippocampus, an elevation descending into the middle horn and terminating as the pes hippocampi, or sea-horse's foot. Between the two hippocampi is the collateral eminence, or accessory foot.

Transverse section of the greater hippocampus shows it to be produced by one of the convolutions, that of the corpus callosum, doubling upon itself, so that the white convexity projects into the middle horn of the ventricle. The gray matter on the surface of this convolution can be seen by raising the edge of the corpus fimbriatum. This gray matter forms the so-called fascia dentata, which is really outside the cavity of the horn and belongs to the external surface of the hemisphere. On the inferior surface of the fornix are some lines resembling a harp, hence called the lyra. Under the fornix is seen the transverse fissure through which the pia mater enters to form the velum interpositum.

The *fifth ventricle* lies between the two layers of the septum lucidum, and is a mere slit, lined with serous membrane. In the fœtus the fifth ventricle communicates with the third ventricle below.

The *velum interpositum* is the delicate veil stretched across the top of the third ventricle, and lying underneath the fornix. It is a portion of pia mater that has entered by the transverse fissure. On its edges are the choroid plexuses of the lateral ventricles. On its inferior surface the choroid plexuses of the third ventricle, and small arteries and veins. The veins. veins of Galen as they are called, empty into the straight sinus.

Third Ventricle.—The space or cavity beneath the velum interpositum and between the two optic thalami is called the third ventricle. Its floor is the lamina cinerea, the tuber cinereum and the adjacent structures, described with the base of the cerebrum. It is crossed by three bands or commissures; the anterior, of white matter, between the two striated bodies, the middle, or gray, commissure between the optic thalami, and the posterior, of white substance, between the optic thalami at the posterior end of the ventricle. There are four openings leading from the third ventricle. In front are the two openings into the lateral ventricles, constituting the foramen of Monro; under the posterior commissure the aqueduct of Sylvius, or the road from the third to the fourth ventricle; and in the floor the opening into the infundibulum.

The Foramen of Monro is the oval opening behind the anterior peduncles of the fornix, through which the choroid plexuses of the lateral ventricles join together, and by which communication between the third and the two lateral ventricles is established.

The Pineal Gland and Corpora Quadrigemina. Under the velum interpositum, and behind the posterior commissure, is seen a reddish-gray body lying upon four small elevations. It is the pineal gland, and the four elevations are called the corpora quadrigemina. The pineal gland is attached to the optic thalami by anterior peduncles, easily seen, and by inferior peduncles, which are only shown by making a vertical section. It consists of gray matter and vessels, and contains small concretions. It is said to have a small cavity within it.

Corpora Quadrigemina.—These four bodies are located behind the third ventricle and over the canal between the third and fourth ventricle. The anterior are called the nates or buttocks, the posterior the testes or testicles. Between the testes and cerebellum run bands, between which lies the valve of Vieussens giving origin to the fourth pair of cranial nerves. The corpora quadrigemina are often called optic lobes, because the optic nerves have their origin in them.

Structure of the Cerebrum.—The white matter of the hemispheres consists of diverging fibres coming from the cord, transverse fibres joining the two hemispheres, and longitudinal fibres joining different parts of the same hemisphere.

THE CEREBELLUM.

The cerebellum lies in the occipital fossa, separated from the cerebrum by the tentorium. It consists of two hemispheres, marked by transverse fissures dividing the surface into layers. The upper surface presents a median ridge, called the superior vermiform process, which connects the hemispheres; and each hemisphere is divided into an anterior and posterior lobe. The lower surface is separated into the hemispheres by a median furrow, the bottom of which is the inferior vermiform process. This process is divided into three portions; that in front is called the nodule, the posterior takes the name of the pyramid, the middle is the uvula. On each side of the uvula there is a projection of the hemisphere called the tonsil. The other portions of the hemisphere of importance are the posterior, slender, and digastric lobes; and in front of the digastric lobe the flocculus, or sub-peduncular, lobe. This lies under the middle peduncle of the cerebellum.

A vertical section of the cerebellum shows in the interior of each hemisphere the ganglion, or dentate body, consisting of gray matter; and the peculiar arrangement of white and gray matter towards the surface, which is called the arbor vitæ. because it resembles the branches of a tree.

The cerebellum is attached to the cerebrum and medulla oblongata by three pairs of peduncles. The superior peduncle extends from the cerebellum to the testes; the middle from the cerebellum to the pons Varolii; the inferior from the cerebellum to the medulla oblongata, forming part of the restiform bodies.

The fourth ventricle is the space between the lower surface of the cerebellum and the medulla oblongata. It is lozenge shaped, and has its sides formed by the converging superior peduncles of the cerebellum above and the diverging posterior columns of the medulla oblongata below. Its floor is the posterior surface of the medulla oblongata and pons, its roof the valve of Vieussens and the cerebellum. It opens above into the third ventricle by the aqueduct of Sylvius (iter a tertio ad quartum ventriculum), and below, at the calamus scriptorius, it communicates with the canal, or ventricle, of the cord. In the floor on each side of the middle line are two longitudinal elevations called the fasciculi teretes; outside of these lies a bluish-gray eminence called the locus cæruleus, or blue spot. The ventricle communicates with the subarachnoid space of the cord by an aperture in the pia mater crossing from the cerebellum to the medulla oblongata. Two vascular fringes projecting into the ventricle at the sides are called choroid plexuses of the fourth ventricle. From the upper part of the floor of the fourth ventricle the sixth and seventh nerves arise, and from its lower half the ninth, tenth, eleventh and twelfth nerves.

THE CRANIAL NERVES.

There are twelve pairs of cranial nerves, all of which, arising from the encephalon, make their exit through openings in the base of the skull. The function of these nerves differs. Some of them are nerves of common sensation, some are nerves of motion, others are nerves of special sense, while a few partake of two characters and have branches with different functions.

NUMBER.	NAME.	FUNCTION.
First,	Olfactory,	Smell,
Second,	Optic,	Sight,
Third,	Motor oculi,	Motion,
Fourth,	Pathetic,	Motion,
Fifth,	Trifacial or Trigeminal,	Sensation (large root), Motion (small root), Taste (a small branch),
Sixth,	Abducent,	Motion,
Seventh,	Facial, or Portio dura,	Motion,
Eighth,	Auditory, or Portio mollis,	Hearing,
Ninth,	Glosso-pharyngeal,	Sensation,
Tenth,	Pneumogastric, or Par vagum,	Motion, Sensation,
Eleventh,	Spinal Accessory,	Motion,
Twelfth,	Hypoglossal,	Motion.

This numbering, proposed by Sömmering, is the better, though some writers still adhere to the old method of Willis, who included the Facial and Auditory under the name of the seventh, and the Glosso-pharyngeal, Pneumogastric and Spinal Accessory under the name of the eighth. The Hypoglossal then becomes the ninth.

TABLE OF CRANIAL NERVES.

Number and Name.	*Superficial Origin.*	*Deep Origin.*	*Foramen of Exit.*	*Function.*	*Principal Branches and Distribution.*
I. Olfactory.	Three roots from lower surface of frontal lobe.	Anterior centre of optic thalamus, and island of Reil.	Cribriform plate of ethmoid.	Smell.	Bulb, which lies on cribriform plate, sends twenty branches to mucous membrane covering septum and two upper turbinated bones. The trunk and bulb are really part of the encephalon, similar to the olfactory lobes in lower animals; they contain gray matter and have no sheath.
II. Optic.	Optic commissure and tracts.	Optic thalamus, and corpora quadrigemina.	Optic.	Sight.	The two optic tracts unite to form the chiasm, or commissure, and thence the two optic nerves proceed to the retinæ. At the commissure the fibres decussate, so that some fibres from the right tract go to the left retina, and vice versa. There are also fibres merely passing from one tract to the other (inter-cerebral); and again some fibres in the front of the chiasm, which simply pass from one retina to the other (inter-retinal fibres).

TABLE OF CRANIAL NERVES.

Number and Name.	*Superficial Origin.*	*Deep Origin.*	*Foramen of Exit.*	*Function.*	*Principal Branches and Distribution.*
III. Motor Oculi.	Inner side of peduncle of cerebrum.	Floor of aqueduct of Sylvius.	Sphenoidal fissure.	Motion.	All muscles of eye, except External rectus, Superior oblique and Orbicularis palpebrarum, and to ciliary ganglion.
IV. Pathetic.	Outer side of peduncle of cerebrum.	Valve of Vieussens.	Sphenoidal fissure.	Motion.	Superior oblique of eye.

TABLE OF CRANIAL NERVES.

Number and Name.	*Superficial Origin.*	*Deep Origin.*	*Foramen of Exit.*	*Function.*	*Principal Branches and Distribution.*
V. Trifacial. This nerve resembles the spinal nerves in having a sensory root, with a ganglion upon it (Casserian ganglion), and a smaller motor root. The motor root becomes part of the inferior maxillary division.	Side of pons Varolii.	*Large or Sensory root.* Posterior horns of gray matter in medulla oblongata.	*Ophthalmic Division.* Sphenoidal fissure.	Sensation.	(1) **Frontal.** supra-orbital, supra-trochlear, } forehead and eyelids. (2) **Lachrymal**; to gland and conjunctiva. (3) **Nasal**; long ciliary to iris; to septum and tip of nose; to ciliary ganglion.
			Superior Maxillary Division. Round foramen.	Sensation.	(1) **Orbital**; temporal to temple; malar to cheek. (2) **Spheno-palatine** to Meckel's ganglion. from ganglion;— Vidian to large petrosal, palatine { anterior, middle, posterior, naso-palatine. (3) **Anterior and Posterior Dental** to upper teeth. (4) **Infra-orbital** to eyelid, nose and lip.

TABLE OF CRANIAL NERVES.

Number and Name.	*Superficial Origin.*	*Deep Origin.*	*Foramen of Exit.*	*Function.*	*Principal Branches and Distribution.*
Trifacial, *Continued.*		*Small or Motor root.* Near same locality as Sensory root.	*Inferior Maxillary Division.* Oval foramen.	Sensation. Motion. Taste.	(1) MOTOR to muscles of mastication, viz.: Temporal, Masseter, Pterygoids. (2) AURICULO-TEMPORAL; to auditory meatus; to otic ganglion. (3) BUCCAL; to cheek. (4) GUSTATORY OR LINGUAL; to anterior part of tongue (taste); to submaxillary ganglion; to Lingualis (motion by chorda tympani of 7th). (5) INFERIOR DENTAL; to teeth; branches;—mental; mylo-hyoid.
VI. Abducent.	Medulla oblongata behind pons Varolii.	Floor of fourth ventricle.	Sphenoidal fissure.	Motion.	External rectus of eye.

TABLE OF CRANIAL NERVES.

Number and Name.	*Superficial Origin.*	*Deep Origin.*	*Foramen of Exit.*	*Function.*	*Principal Branches and Distribution.*
Pneumogastric—(*Continued*)					*Inferior or Recurrent,* Motion to intrinsic muscles of larynx, except Crico-thyroid. (4) Cardiac. Motion. (5) Pulmonary. Motion (?) (6) Œsophageal. Motion. (7) Gastric. Motion.
XI. Spinal Accessory.	Behind olivary body; and from lateral tract of spinal cord, as low as sixth cervical nerve.	Below that of X; and from anterior gray horn of cord.	Jugular Foramen.	Motion.	It is so called because it is the *spinal* nerve *accessory* to the pneumogastric, with which it soon unites. It probably supplies motor influence to the pneumogastric. Distributed to Sterno-cleido-mastoid and Trapezius.

TABLE OF CRANIAL NERVES.

Number and Name.	*Superficial Origin.*	*Deep Origin.*	*Foramen of Exit.*	*Function.*	*Principal Branches and Distribution.*
XII. Hypo-glossal.	In front of olivary body of medulla oblongata.	Floor of fourth ventricle.	Anterior condyloid foramen.	Motion.	Distributed to the "glossus" and "hyoid" muscles, except Palato-glossus (5th), Mylo-hyoid (5th), and Stylo-hyoid (7th). DESCENDING BRANCH, or Descendens Noni, which communicates with 2nd and 3d cervical by the so-called Communicans Noni of the cervical plexus.

All these cranial nerves, with the exception, perhaps, of the olfactory and optic, have branches of communication with neighboring cranial, spinal, and sympathetic nerves; but no mention has been made of these, except in cases where they were specially important. It is to be observed that those whose function is common sensation, have ganglia, similar to the sensory, or posterior, roots of spinal nerves. This analogy is greatest in the case of the fifth nerve, which has a small motor root without a ganglion, and a large sensory root with one. The pneumogastric presents a similar character, if the spinal accessory be looked upon as its motor root.

Connected with the fifth, or Trifacial nerve, there are a number of sympathetic ganglia, which had better be described in this place, although the general sympathetic nervous system has not yet been discussed.

Each ganglion has a communication, or root, with a motor, a sensory and a sympathetic nerve; and then furnishes branches to neighboring structures.

Median, from outer and inner cord.

Branches	anterior interosseous, muscular,	to pronators, to flexors,* and to first 2 Lumbricals.
	cutaneous, to integument of radial half of palm and 3½ fingers.	

Ulnar, from inner cord.

Branches
- articular, to elbow and wrist.
- muscular, to muscles of little fingers, all Interosseous, last two Lumbricals, and Ulnar flexor of wrist.
- cutaneous, to integument of ulnar half of palm, and of dorsal and palmar surfaces of 1½ fingers.

DORSAL NERVES.

There are twelve pairs of dorsal nerves, which have their exit below the corresponding vertebræ and have posterior, or dorsal branches, supplying the skin and muscles of the back; and anterior, or intercostal branches, distributed to the chest and abdomen. The intercostals do not unite in plexuses, but each one runs separately in the groove at the lower margin of the corresponding rib, and has muscular and cutaneous branches. The only branch requiring special notice is the lateral cutaneous branch of the second intercostal, which is better known as the *Intercosto-humeral.* This large nerve pierces the chest wall, and crosses the axilla to join the lesser internal cutaneous (Wrisberg) of the arm. The first dorsal nerve is peculiar, because the greater portion of its fibres go to form the lower part of the brachial plexus. Its intercostal branch is, therefore, small.

LUMBAR NERVES.

The five pairs of lumbar nerves leave the spinal canal by the foramina under the corresponding vertebræ. The posterior branches supply the back; while the anterior branches of the first four nerves coalesce to constitute the lumbar plexus. The anterior branch of the fifth and a communicating branch from the fourth form the *lumbo-sacral* nerve, which is a constituent of the sacral plexus, as will be shown later.

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* The Deep flexor of fingers is supplied by both median and ulnar; the Ulnar flexor of wrist by ulnar nerve.

LUMBAR PLEXUS.

Formed from anterior branches of first four lumbar.

The branches constituting this plexus are united by loops of communication, and the six nerves proceeding from it are: two from the 1st lumbar; two from the 2d; one from the 3d and one from the 4th lumbar, both of which bifurcate and then form two nerves by union of their bifurcations.

Lumbar Plexus.	1st Lumbar,	ILIO-HYPOGASTRIC, to gluteal region and abdomen.
		ILIO INGUINAL, to inguinal region and scrotum.
	2d Lumbar,	GENITO-CRURAL, to spermatic cord and front of thigh.
		EXTERNAL CUTANEOUS, to outside of thigh.
	3d Lumbar,	OBTURATOR, through obturator canal to External obturator and Adductors and to knee joint. *Accessory obturator*, to Pectineus and hip joint (often absent).
	4th Lumbar,	ANTERIOR CRURAL, *Middle cutaneous*, to front of thigh. *Internal cutaneous*, to inside of thigh and leg. *Long saphenous*, to inside of leg and foot. *Muscular*, to muscles of front of thigh. *Articular*, to knee joint.

SACRAL NERVES.

The roots of the sacral and coccygeal nerves are long and form the cauda equina. There are five sacral; and, therefore, the lower one must make its exit at the foramen between the sacrum and coccyx.

SACRAL PLEXUS.

Formed from anterior branches of upper four sacral and 5th lumbar, with a branch from 4th lumbar. The branch from the 4th lumbar unites with the 5th lumbar, forming the *lumbo-sacral* cord, or nerve, which coalesces with the anterior branches of the 1st, 2d, 3d, and 4th sacral to form a single flat band and thus complete the plexus. The plexus lies upon the front of the Pyriformis, and is triangular, with the apex towards the great sacro-sciatic notch, through which the greater portion escapes from the pelvis, below the Pyriformis.

Branches of sacral Plexus :—

- MUSCULAR, to external rotators on buttock (viz: Internal obturator, Gemelli, Quadratus femoris and Pyriformis.
- SUPERIOR GLUTEAL, to Middle and Smallest Gluteals.
- PUDIC, re-enters pelvis by small sacro-sciatic foramen, to anus, perineum and genitals.
- SMALL SCIATIC, to Great gluteal and back of thigh and leg.
- GREAT SCIATIC, largest nerve; lies midway between tuberosity of ischium and great trochanter; to flexors of leg.
  - *Internal Popliteal*, to calf muscles, Popliteus, and knee joint.
    - *Posterior Tibial*, to Posterior tibial muscle and Long flexors.
      - internal plantar, to sole of 3½ toes, a few Lumbricals.
      - external plantar, to sole of 1½ toes, Interosseous, a few Lumbricals.
    - *Short Saphenous*, to outside of foot and outside of 5th toe.
  - *External Popliteal*, or *Peroneal*, back and outside of leg, to knee joint,
    - *Communicating* (communicans peronei), to join short saphenous.
    - *Musculo-cutaneous*, to Peroneals, to top of toes, except adjacent sides of 1st and 2d.
    - *Anterior tibial*, to Anterior tibial muscle, extensors of all toes, and adjacent sides of 1st and 2d toes.

COCCYGEAL.

There is only one coccygeal nerve. It has an anterior and a posterior branch, which are distributed about the coccyx. It is unimportant.

THE SYMPATHETIC NERVOUS SYSTEM.

The sympathetic system consists of a series of ganglia, situated on each side of the spinal column and in the skull, and connected together by communicating branches. From these ganglia are distributed branches to the most remote regions of the trunk and extremities. The sympathetic system is often called the nervous system of organic life, because its abundant distribution to the viscera seems to imply its intimate connection with the organic functions of growth and nutrition.

These ganglia may be considered as distinct nervous centres, having branches of communication between themselves, branches of connection with the cerebro-spinal nerves, and branches of distribution to the viscera, arteries and the cardiac and semilunar ganglionic masses. The sympathetic nerve has a tendency to form intricate plexuses about the arteries. The ganglia of the head, already described with the cranial nerves, lie between the cranial and facial bones. The cervical and dorsal ganglia are situated on each side of the vertebral bodies; while the lumbar, sacral, and coccygeal, lie in front of the corresponding bones. The single coccygeal ganglion (ganglion impar), situated in the middle line, joins the gangliated cords of the two sides together; and it is believed by some that the cranial ganglia are in a similar manner united above by a ganglion, (of Ribes) located on the anterior communicating artery of the cerebrum.

The number of ganglia on each side varies somewhat, because they occasionally coalesce. The regions have usually the number assigned in the table below:—

Cerebral portion, 1 in middle line, if it really exists, ganglion of Ribes.
Cephalic portion, 4 on each side.
Cervical " 3 " "
Dorsal " 12 " "
Lumbar " 4 " "
Sacral " 5 " "
Coccygeal " 1 in middle line.

CEPHALIC GANGLIA.

These have already been described, with the cranial nerves, on page 134. They are named the ophthalmic, the spheno-palatine, the otic, and the sub-maxillary.

CERVICAL GANGLIA.

There are three in number on each side, and are called superior, middle and inferior. The superior, and largest, lies alongside of the third cervical vertebra and behind the carotid sheath; the middle is small and sometimes absent, and lies opposite the fifth vertebra near the inferior thyroid artery; the inferior is located on a level with the seventh vertebra and near the superior intercostal artery.

The important branches from these ganglia, in addition to the various communicating branches to the cerebro-spinal nerves, are: —

From
Superior ganglion { carotid plexus.
cavernous plexus.
pharyngeal plexus.
superior cardiac nerve. }
Middle " middle cardiac nerve. } to cardiac ganglia
Inferior " inferior cardiac nerve. } and plexuses.

CARDIAC NERVES.

There are three cardiac nerves on each side, derived, as shown above, one from each cervical ganglion.

(1) Superior, or superficial cardiac, nerve, { right side, behind arch of aorta to deep cardiac plexus.
left side, front of arch of aorta to superficial cardiac plexus.

(2) Middle, or great cardiac, nerve, both sides, behind subclavian to deep cardiac plexus.

(3) Inferior, or small cardiac, nerve, both sides, behind subclavian to deep cardiac plexus.

The deep or great cardiac plexus is placed in front of the bifurcation of the trachea and behind the arch of the aorta. It is formed from all the cardiacs except the two mentioned below as forming the superficial plexus. Its branches form the posterior coronary plexus.

The superficial cardiac plexus lies in front of the right pulmonary artery, and is formed by the left superior cardiac nerve and the inferior cardiac branches of the left pneumogastric. There is sometimes a small ganglion situated here, called the ganglion of Wrisberg. The branches of this plexus are distributed to the right coronary artery, forming the anterior coronary plexus.

THE DORSAL OR THORACIC GANGLIA.

The twelve thoracic ganglia of each side are placed behind the pleura against the heads of the ribs. The important branches of the first six ganglia are small, and supply the aorta and form the posterior pulmonary plexuses. The anterior pulmonary plexuses are formed from the deep cardiac plexus. The six lower ganglia have large branches, which unite to form three important nerves; the great, the lesser, and the smallest or renal, splanchnic nerves.

Great Splanchnic, from 6th–9th ganglia (connecting with upper six); through crus of diaphragm, to semilunar ganglion and solar plexus.

Lesser Splanchnic, from 10th–11th ganglia; through crus of diaphragm, to semilunar ganglion and solar plexus.

Smallest Splanchnic, from 12th ganglion; through crus of diaphragm, to renal plexus.

The Solar Plexus and Semi-lunar Ganglia.

The solar plexus, or "belly brain," consists of ganglia and a network of nerve branches, lying behind the stomach, in front of the aorta, and surrounding the cœliac axis and superior mesenteric artery. It receives the greater and lesser splanchnics of both sides, and the right pneumogastric nerve. Alongside of the plexus proper are found two semilunar, or crescentic, ganglionic masses, formed of small ganglia. Each *semi-lunar ganglion* lies near the supra-renal capsule, and alongside of the cœliac axis and superior mesenteric artery. Between the semi-lunar ganglia the network of the solar plexus is found.

The solar plexus is single, and from its branches are formed plexuses accompanying the arteries of the abdomen. They correspond closely, therefore, with the branches of the aorta, and in certain places have additional ganglia. Where the arteries occur in pairs, the plexuses do the same; when the arteries are single, but one plexus is required.

The plexuses derived from the solar plexus and semilunar ganglia are:—

Phrenic,
Cœliac,
Gastric,
Hepatic,
Splenic,
Supra-renal,
Renal,
Superior Mesenteric,
Spermatic or Ovarian,
Inferior Mesenteric,
Aortic (partly also from lumbar ganglia).

Plexuses are distributed to the branches of these arteries in a similar manner; as, indeed, are sympathetic filaments to the arteries throughout all the extremities.

LUMBAR GANGLIA.

The four lumbar ganglia lie in front of the vertebral bodies, at the inner margin of the Great psoas. The branches aid in forming the aortic and hypogastric plexuses.

SACRAL AND COCCYGEAL, OR PELVIC GANGLIA.

The five sacral, on each side, and the single coccygeal ganglion (ganglion impar), lie in front of the sacrum and coccyx. The branches from the lumbar and those from the first two sacral ganglia form the single hypogastric plexus, lying in front of the sacral promontory. This divides below, and, with the branches from the remaining ganglia, makes the two inferior hypogastric, or pelvic, plexuses. From these are distributed branches forming plexuses for the bladder, vagina, uterus, rectum (hemorrhoidal), prostate and other pelvic viscera.

CHAPTER VI.

THE ORGANS OF DIGESTION.

Under the term digestive apparatus are included the mouth, pharynx, œsophagus, stomach, large and small intestines, and certain accessory organs, which have functions necessary to the completion of the digestive process. The accessory organs located within, or in the vicinity of, the mouth are the teeth, tongue and salivary glands; those situated in the abdomen are the liver and pancreas. The spleen, although not an organ of digestion, is usually described with the other abdominal organs.

THE MOUTH is an oval cavity, in which the food is masticated, or chewed, preparatory to deglutition, and which also serves as an entrance to the respiratory tract. It is bounded by lips, cheeks, jaws, palate and tongue, and opens posteriorly into the pharynx. The lining mucous membrane is continuous with that of the pharynx and œsophagus.

THE TEETH are imbedded in the alveolar processes of the jaws and are surrounded by the gums, which are composed of fibrous tissue covered with mucous membrane of slight sensibility. There are two sets of teeth: the temporary, or milk, teeth of childhood: and the permanent, which appear after the shedding of the milk teeth and last during the greater part of adult life. The temporary teeth are ten, the permanent sixteen, in number in each jaw; which makes in both jaws twenty temporary and thirty-two permanent teeth. The teeth of each half of each jaw are:—

Temporary	incisors, two. canine, one. molars, two.	Permanent	incisors, two. canine, one. bicuspids, two. molars, three.

All teeth have a crown, or body, which is the portion seen above the gum; a root, or fang, inserted into the socket in the jaw; a neck, or constriction, between the crown and the fang. A vertical section of a tooth shows a cavity in the interior, called the pulp cavity, which is continuous with an orifice in the point of the fang. Vessels and nerves enter the pulp cavity by this small aperture. The main portion of the tooth consists of dentine, which is composed of tubes, lying in the inter-tubular tissue. The tubules open into the pulp cavity and contain prolongations of the pulp tissue, called dentinal fibres. The dentine forming the crown is covered by a layer of very hard and compact tissue, called enamel; while the fang is in a similar way covered by a layer of bone-like material, called the cement or crusta petrosa.

THE TEMPORARY TEETH are smaller than the permanent, but similar in structure. There are five in each half of each jaw, namely: two incisors, one canine, two molars. The molars occupy the positions subsequently filled by the bicuspids of the permanent set.

THE PERMANENT TEETH.—The incisors have a sharp cutting edge, and are situated in the front of the mouth. They number four in each jaw. The canine are placed one on each side of the incisors, thus making two in each jaw; and have a conical pointed crown adapted to tearing food. The upper canines are popularly known as eye teeth, the lower as stomach teeth. There are two bicuspids situated behind each canine. They have two eminences, or cusps, on the grinding surface of the crown, and the fangs, though single, like those of the teeth already described, show a tendency to bifurcation at the extremities and are grooved by a line, as though the separation into two roots had not been completed. The molars, the largest teeth, are the most posterior, and number three on each side of each jaw. They have large crowns, divided into four or five cusps, or points, and are the grinding teeth. The root consists of from two to five long processes, each of which has an opening for the entrance of vessels and nerves. The most posterior molars are called wisdom teeth.

The eruption of the temporary teeth begins at the age of seven months, and is finished when the child is two or two and a half years old. The teeth in the lower jaw usually show themselves before the corresponding ones of the upper jaw. The permanent teeth make their appearance between the sixth and twenty-first year; and those of the lower jaw usually manifest themselves before their antagonists of the upper jaw.

The time of eruption of the two sets is approximately as follows:—

TEMPORARY,	
central incisors,	7 months.
lateral incisors,	7 to 10 months.
anterior molars,	12 to 14 months.
canines.	14 to 20 months.
posterior molars,	18 to 36 months.
PERMANENT,	
first molars,	6½ years.
central incisors,	7 years.
lateral incisors,	8 years.
first bicuspids,	9 years.
second bicuspids,	10 years.
canines,	11 to 12 years.
second molars,	12 to 13 years.
third molars,	17 to 21 years.

THE PALATE.

The hard palate, consisting of the palate processes of the superior maxillary and palate bones, and covered with mucous membrane, forms the roof of the mouth and the floor of the nose. The soft palate, formed of muscles and fascia covered by mucous membrane, hangs from the posterior edge of the hard palate. At the middle of its free border is a pendulous process, called the uvula; on each side of which are seen two cresentic folds, or arches, of mucous membrane, stretching over to cover the Palato-glossus and Palato-pharyngeus muscles. These folds and projecting muscles form the anterior and posterior pillars of the palate, sometimes called pillars of the fauces. Between them on each side lies the tonsil gland, presenting a dozen small follicles.

THE SALIVARY GLANDS.

These glands, situated about the mouth, furnish saliva in large quantity during the process of mastication; and a certain amount of fluid is secreted during the intervals between the times of taking food. Their structure is conglomerate; that is, they consist of many small lobules united together to form larger lobes. The three salivary glands are named, parotid. submaxillary, and sublingual.

The parotid lies in front of and below the ear, extending from the zygoma down to the level of the angle of the lower jaw. The external carotid artery, as it ascends, is surrounded by it, and the facial nerve passes through it transversely.

Just below the zygoma and lying on the Masseter muscle is seen a detached lobe of the gland, called socia parotidis (the associated parotid). The duct of the parotid, called Steno's duct, is two and a half inches long, and opens into the mouth upon the inside of the cheek, opposite the second molar tooth of the upper jaw. It corresponds, in direction, with a line drawn from the base of the lobule of the ear to the middle of the upper lip. The submaxillary gland lies under the lower border of the lower jaw, in the submaxillary triangle, and is separated from the parotid by the stylo-maxillary ligament, and from the sublingual by the Mylo-hyoid muscle. The facial artery is imbedded in it. The duct, named after Wharton, opens alongside of the frenum of the tongue.

Under the mucous membrane of the floor of the mouth, close to the inside of the symphysis of the jaw, is found the smallest of the salivary glands, the sublingual. It has ten to twenty small ducts, called the ducts of Rivini; some of which open separately alongside of the frenum, while others join together, forming the duct of Bartholine, which connects with the duct of the sub-maxillary gland.

THE PHARYNX AND ŒSOPHAGUS.

The pharynx is a dilatation of the upper part of the œsophagus, and extends from the basilar process of the occipital bone to the level of the cricoid cartilage and fifth cervical vertebra. It has opening into it the two posterior nostrils, the two Eustachian tubes, the mouth, the larynx and the œsophagus.

The œsophagus is the continuation of the pharynx, and is a tube, about nine inches in length, extending to the cardiac end of the stomach. It is situated in the posterior mediastinum, in front of the vertebral column, and behind the trachea and great vessels. There is an opening in the diaphragm for its passage to the stomach. The œsophagus has an external coat, composed of circular and longitudinal muscular fibres, a middle coat of cellular tissue, and an internal mucous coat.

THE ABDOMEN.

As the digestive organs are to a great extent contained in the abdominal cavity, it becomes necessary to describe this portion of the trunk, before proceeding to the details of the proper and accessory organs of digestion. The abdomen is a large cavity extending from the diaphragm above to the brim of the pelvis below, and bounded in front and at the sides by ribs, muscles and the iliac bones, and behind by the vertebral column, the ribs and muscles. There are several openings in the walls of the abdomen; in the anterior wall, the umbilicus for the passage, during fœtal life, of the umbilical vessels, the two openings for the femoral vessels, and the two inguinal canals for the spermatic cords or round ligaments; in the superior wall (diaphragm), are the apertures for the aorta, vena cava and œsophagus.

The abdomen is divided into nine regions by four imaginary lines, drawn over its anterior surface. The two horizontal lines are drawn across at the level of the ninth costal cartilages and at the top of the iliac crests; the two vertical lines from the cartilages of the eighth ribs to the middle of Poupart's ligaments. The three median spaces, thus mapped out, are named from above downwards; epigastric, umbilical and hypogastric regions. The lateral spaces are denominated right and left hypochondriac, lumbar, and inguinal regions. The inner surface of the abdominal walls is covered entirely, and the organs to a great extent, by a serous membrane, called peritoneum.

THE PERITONEUM.

This is a serous sac, with no opening in the male; but with openings in the female, at the ends of the Fallopian tubes, where the mucous membrane, lining these, is continuous with the peritoneum. The portion of peritoneum covering the wall of the abdomen is called the parietal, that investing the viscera, the visceral, peritoneum. The peritoneum completely covers a number of the viscera, and, where it leaves their surfaces, forms ligaments consisting of two layers by which they are attached to the abdominal wall, or to adjacent organs. A few of the viscera lie behind the peritoneum covering the back of the abdomen, and are therefore called post-peritoneal organs.

The reflections of the peritoneum, as seen in an antero-posterior section of the body, may be described as follows: Taking for a beginning two points, one at the back and the other at the front of the diaphragm, we find that the peritoneum covers the lower surface of this muscle; opposite the back of the liver the layer from the front joins the layer from the back, and they pass to the surface of the liver, forming its coronary ligament. The two layers then separate to envelope the liver, and, when opposite the lesser curvature of the stomach, unite and pass over to it, constituting the gastro-hepatic ligament (or omentum). The stomach is then invested, after a separation of the layers, and from its greater curvature the two layers, again united, pass downward for about six inches. They then make a sharp bend and curve upwards, until they meet the transverse colon, where they divide and encircle this portion of the great intestine. From the transverse colon the two layers, again united, pass back to the spinal column, to attach the colon to the posterior abdominal wall, thus forming a ligament called the meso-colon. From this point we are obliged to consider each layer separately. The upper layer of the meso-colon, which has all along been the posterior layer, passes up the posterior wall to its starting point at the back of the diaphragm. The lower layer of the meso-colon, which has been the anterior layer all the time, descends along the vertebral wall until opposite the small intestines; here it is carried across to the small bowels, and, having invested them with a complete covering, rèturns to the vertebral wall, thus forming a ligament to hold them in position, called the mesentery. After forming in this manner the mesentery, it descends along the front of the spine into the pelvis, surrounds the upper part of the rectum (forming the meso-rectum), and then passes to the top of the bladder and up the anterior belly-wall to the starting point at the front of the Diaphragm. In the female it extends from the rectum to the top of the vagina and uterus, before reaching the bladder.

The Great Omentum.—The portion of peritoneum hanging down from the stomach and bending upwards to the colon is called the gastro-colic ligament or omentum, or more frequently the great omentum.. It consists of four layers with a cavity, between the second and third layers, that is a part of the cavity enclosed by the posterior layer of peritoneum, which we traced from the back of the diaphragm. This cavity is named the *lesser peritoneal cavity*, or cavity of the great omentum. The large space formed by the reflections of the anterior layer, which started from the front of the diaphragm, is denominated the *greater peritoneal cavity*. The lesser and greater peritoneal cavities communicate with each other by the foramen of Winslow, which is an opening large enough to admit the finger, located behind the right border of the gastro-hepatic or lesser omentum. The left border of this omentum is not free, but attached to the lower extremity of the œsophagus between the Diaphragm and stomach.

This description of the manner in which the peritoneum, as seen in an antero-posterior section, invests the viscera, would be incomplete if it were not stated that the membrane passes laterally from the organs to the sides of the abdomen and from one organ to another. Thus are formed lateral ligaments for the liver, and where it passes upwards from the liver there is made a suspensory ligament. It passes likewise from the stomach to the spleen, forming the gastro-splenic ligament or omentum from the spleen to the Diaphragm, making a suspensory ligament; and from the spinal column laterally, covering the front of duodenum, and the ascending and descending colon. The kidneys, suprarenal capsules and pancreas are situated behind the peritoneum, between it and the spinal column and ribs.

The Foramen of Winslow.—There would be left a large communicating space, between the lesser and greater peritoneal cavities, at the right edge of the gastro-hepatic omentum, if it were not that the gastric and hepatic arteries (which, coming from the cœliac axis, lie behind the peritoneum) pushed the peritoneum in front of them, as it were, in their passage to the stomach and liver. This, causing a diminution of the opening of communication, gives the appearance of a narrow canal or foramen connecting the two peritoneal cavities. Nothing passes through this foramen of Winslow, and it is really only a constriction, or narrowing, of the general peritoneal sac or cavity, which is thus made to appear like two cavities connected by a neck-like orifice. This may be illustrated, in a familiar way, by taking a large bag, with the mouth sewed shut, and tying a cord loosely around it near one extremity. The larger portion of the bag represents the greater peritoneal cavity; the smaller, the lesser cavity of the peritoneum; the constricted orifice between them, the foramen of Winslow; and the cord, the gastric and hepatic arteries curving around the general sac in such a manner that a constriction of the cavity within is produced.

THE STOMACH.

The stomach is a dilatation of the intestinal tract, which has for its function the chymification of the food introduced through the mouth and œsophagus. It is a pouch, lying under the diaphragm, in the epigastric and left hypochondriac regions, and has a greater curvature, a lesser curvature, a cardiac or œsophageal extremity, and a pyloric or intestinal end. It is about ten inches in length and about five in vertical diameter at its widest part. The walls are composed of four coats, a serous or peritoneal, which is external, a muscular, a sub-mucous, and an internal or mucous. The muscular coat consists of fibres running in three directions, hence called longitudinal, circular and oblique fibres The longitudinal are continuous with the longitudinal fibres of the œsophagus, the circular run around the organ, while the oblique are found in the vicinity of the cardiac orifice. The mucous membrane presents under the microscope a honeycomb appearance, due to the many-sided alveoli or depressions found in it. In the bottom of these depressions are seen the openings of the glands of the stomach; of which those near the pyloric end are supposed to secrete the gastric mucous, the remainder the acid gastric juice for digestion.

THE SMALL INTESTINE.

The small intestine is about twenty feet long, and is divided into the duodenum, jejunum and ileum.

DUODENUM.—The duodenum is ten inches long and consists of the ascending, descending and transverse portions. It is the first part of the intestine, and has lying within its curvature the right extremity or head of the pancreas. It is only partially invested with peritoneum, and has opening into its descending portion the common bile duct and the pancreatic duct.

JEJUNUM.—The jejunum is two-fifths of the remainder of the small intestine, and extends from the duodenum, which ends at the left side of the second lumbar vertebra, to the ileum. There is no exact point marking the termination of the jejunum and the beginning of the ileum.

ILEUM.—This is the name given to the remaining three-fifths of the small bowel, which extends to the commencement of the large intestine. Observe the different spelling of ileum, the bowel, and ilium, the bone.

The small intestine has, like the stomach, four coats, serous, muscular, cellular or sub-mucous, and mucous. The muscular coat has external or longitudinal fibres and internal or circular fibres. The mucous membrane presents upon its surface columnar epithelium; valvulæ conniventes or transverse ridges, formed by reduplications of the mucous and sub-mucous coats, whose purpose seems to be to retard the intestinal contents and give more absorbing surface; and the villi, which are minute projections, containing blood-vessels and lacteals, covering the mucous membrane.

THE GLANDS OF THE SMALL INTESTINE are the simple follicles (of Lieberkühn) found throughout the small intestine; the duodenal, or Brunner's glands, resembling in structure the pancreas, and found only in the duodenum and upper part of jejunum; the solitary glands found throughout the small bowel, though they are more numerous in its lower part, and which are now looked upon as belonging to the lymphatic system; and finally Peyer's glands or patches. The glands of Peyer are to be regarded as composed of numerous solitary glands, collected together in patches. There are about two dozen such patches found throughout the small intestine; but they are larger and more numerous in the lower part of the ileum than elsewhere, although they have been seen even in the duodenum. They may be circular or oval; when oval the long diameter corresponds with the length of the intestinal tube. Large ones may be four inches long.

The characteristics of the parts of the small bowel may be stated as follows:—

DUODENUM.	JEJUNUM.	ILEUM.
Largest in diameter.	More vascular than ileum.	Less vascular than jejunum.
Thickest coats.	Valvulæ conniventes marked.	Valvulæ conniventes almost absent.
Valvulæ conniventes.	Villi marked.	Villi small.
Brunner's glands.	Few Peyer's patches.	Many and large Peyer's patches.
No mesentery.		

THE LARGE INTESTINE.

The large intestine is five feet long, extends from the ileum to the anus, and is characterized by its large calibre, sacculated appearance and comparative immobility. It begins in the right inguinal region, ascends to the liver, crosses the abdomen, descends on the left side, and then enters the pelvis to descend along the front of the sacrum to the anus. Its subdivisions are cæcum, colon, rectum; and the colon is further divided into the ascending, transverse and descending portions, and the sigmoid flexure.

Cæcum.—This blind pouch forms the beginning of the large intestine, and shows at its junction with the ascending colon the entrance of the ileum. At this orifice is situated the ileo-cæcal valve, consisting of two leaflets. They are formed by reduplications of the mucous membrane and by circular muscular fibres, over which the longitudinal fibres pass continuously. The surfaces of the valve differ, because the side towards the ileum has its characteristic mucous membrane, and that towards the cæcum the peculiarities of the membrane lining the great intestine. From the lower and posterior part of the cæcum hangs the vermiform appendix, which is a long, worm-like tube, that is an analogue of the lengthened cæcum found in many animals.

Colon.—The ascending colon extends from the cæcum to the lower surface of the liver, where it bends to the left to become the transverse portion of the colon. The transverse extends from this hepatic flexure to the splenic flexure on the left side; here the great intestine passes downwards to the left inguinal region, where it makes a number of turns and becomes narrower. This portion is named the sigmoid flexure, and extends to the beginning of the rectum. The transverse colon has the great omentum attached to it.

Rectum.—This portion of the bowel is about eight inches in length, and is not sacculated. It begins at the left sacro-iliac joint, and, reaching the middle line of the sacrum, descends to the anus after making a bend backwards around the point of the coccyx. It is distended just above the anus to form a sort of pouch. The transverse colon is the only portion of the great bowel that is almost completely invested by peritoneum, which here, as previously stated, forms the transverse meso-colon. The other portions are, as a rule, only covered by the peritoneum in front and perhaps laterally; though in some instances there is more or less meso-colon in other parts of the bowel. The lower part of the rectum has no peritoneum whatever.

The large intestine has a serous, a muscular, a cellular or sub-mucous, and a mucous coat. Along the colon and part of the rectum there are attached numerous small pouches of peritoneum, containing fat; these are the omentum-like appendixes (appendices epiploicæ). The sacculated appearance of the colon is due to the longitudinal fibres of the muscular coat being collected into three narrow bands, which are shorter than the gut, and hence cause it to become pouched. These bands are readily seen. The mucous membrane of the great intestine is smooth and without villi. It presents columnar epithelium, simple follicles and solitary glands. The latter are more abundant at the beginning of the large intestine than elsewhere in its extent.

THE LIVER.

The liver is a large gland, secreting bile and causing certain changes to take place in the blood. It is located mainly in the right hypochondriac and the epigastric regions. It weighs three pounds, and has the following dimensions: thickness, 3 inches; antero-posterior diameter, 6 inches; transverse measurement, 12 inches. The gland is convex on its upper surface, concave on its lower; has a rounded posterior and a sharp anterior border. It has five ligaments, five fissures, five lobes, and five sets of vessels.

LIGAMENTS.

Suspensory, falciform, or broad; above.
Two lateral; one at each side.
Coronary; behind.
Round; which is the obliterated umbilical vein.

FISSURES (ALL ON UNDER SURFACE).

Longitudinal; in which the round ligament lies.
Fissure of ductus venosus; being posterior half of longitudinal.
Transverse; where vessels enter liver.
Fissure for the gall bladder.
Fissure for vena cava.

LOBES.

Right.
Left.
Square (lobus quadratus); between longitudinal fissure and fissure for gall bladder.
Lobe of Spigelius; between fissures for ductus venosus and vena cava.
Caudate lobe; joining lobe of Spigelius and right lobe.

VESSELS.

1. Portal vein,
2. Hepatic duct,
3. Hepatic artery,
4. Lymphatics,

} in transverse fissure.

5. Hepatic veins; seen at back, opening into vena cava.

Structure.—The liver is made up of lobules, which are small granular bodies about one-tenth of an inch in diameter, and grouped about the small branches of the hepatic veins. Every lobule consists of liver cells, capillary bile ducts, capillaries of the portal vein, of the hepatic veins, and of the hepatic artery, and probably contains in addition nerves and lymphatics. As previously described, the portal vein brings blood to the liver, from which bile is formed; the hepatic, or bile, duct carries the bile towards the gall bladder and duodenum; the hepatic artery furnishes arterial blood for the nutrition of the various parts of the organ; and the hepatic veins return the venous blood, no longer needed, to the vena cava. The small branches of the portal vein run between the lobules, and are denominated *inter*-lobular veins; smaller branches from these enter the lobules and form *intra*-lobular veins. These empty into a larger vein, around which the lobules are grouped, called the *sub*-lobular vein. From these sub-lobular veins the hepatic veins are formed. The vessels, as they enter the liver by the transverse fissure, are covered by areolar tissue, which follows them in their ramifications through the liver structure. This is the capsule of Glisson. It is probable that the capillaries of the bile duct, portal vein, hepatic vein and hepatic artery inter-communicate in the interior of the organ.

Gall Bladder.—This reservoir for the bile lies under the anterior edge of the right lobe of the organ. It holds about eight fluid drachms, and has a duct, the cystic, which joins the hepatic duct about an inch and a half below the exit of the latter from the liver. The junction of these two ducts forms the common bile duct (ductus communis choledochus), which empties into the descending duodenum, near the entrance of the pancreatic duct. It will be seen that the gall bladder is a receptacle for storing bile, until it is required during the digestive process. It is filled by the bile passing up the cystic from the hepatic duct; when required, the fluid passes down the cystic and onward in the common duct to the intestine.

THE PANCREAS.

This gland resembles the salivary glands, in being conglomerate; that is, made up of small lobules whose ducts unite with those of other lobules to form larger lobules, or lobes. It is six inches long, is located across the spinal column, behind the stomach, and has a tail toward the spleen and a head lying in the concavity of the duodenum. Its duct runs transversely and opens into the descending part of the duodenum.

THE SPLEEN.

The spleen is a ductless organ or gland, having some function in connection with the blood corpuscles, of which we know comparatively little. It lies to the left of the cardiac end of the stomach, to which it is attached by the gastro-splenic omentum. It has a suspensory ligament, consisting of peritoneum, holding it to the Diaphragm. The proper spleen substance is enclosed in a network of tissue like connective tissue, and is reddish-brown in color. A section of the spleen reveals, connected with the arterial capillaries, numerous semi-opaque, whitish bodies, called corpuscles of Malpighi. These are capsules, or sacs, containing a semi-fluid substance, and are said to be large when the animal has been well fed. They are believed to be a portion of the lymphatic system.

CHAPTER VII.

ORGANS OF CIRCULATION AND RESPIRATION.

THE THORAX.

The thorax is the upper portion of the trunk, and is formed by the dorsal vertebræ, ribs, costal cartilages and sternum. It is separated from the abdomen below by the Diaphragm; and contains, among other structures, the heart, pericardium, lungs, pleura, great vessels, trachea, and œsophagus.

THE CIRCULATORY ORGANS.

THE PERICARDIUM.

This membranous sac has two layers; the external or parietal, which is fibro-serous, and forms a conical bag with its base on the Diaphragm and its apex about the great vessels; and the internal, or visceral, which is serous, and closely invests the heart and the root of the great vessels for two inches. Between these layers is the cavity of the pericardium, usually containing a small amount of serous fluid.

THE HEART.

The central organ of circulation, called the heart, is a hollow muscle of conical shape, placed in the thorax with its base upwards, backwards, and to the right, and its apex pointing downwards, forwards and to the left. It extends from the upper edge of the third costal cartilages to the level of the sixth cartilage; and has its apex behind the fifth intercostal space, about one inch within, and two inches below the left nipple. Its weight is a little over half a pound. Its interior is lined by a serous membrane, the endocardium, as its exterior is covered by the visceral pericardium. It is divisible into a right or venous, and a left or arterial, side. Each side consists of two cavities, an auricle and a ventricle The superior cavities are the auricles and have much thinner walls than the ventricles. The venous blood, from the vena cava and the proper veins of the heart walls, is poured first into the right auricle; then, passing through the right auriculo-ventricular opening, it enters the right ventricle. From here it goes to the lungs by the pulmonary artery; after receiving oxygen, it is conveyed to the left auricle by the pulmonary veins, and then passes into the left ventricle, and finally into the aorta.

THE RIGHT AURICLE has connected with its cavity the auricular appendix, a small sac overlying the root of the pulmonary artery. The openings into the right auricle are: the superior vena cava and inferior vena cava, with the unimportant and scarcely visible tubercle of Lower between them; the coronary sinus and veins of Thebesius, bringing venous blood from the walls of the heart; and the opening into the ventricle, guarded by the tricuspid valve. The other points to be noticed are: the Eustachian valve, below the opening of the inferior vena cava; the coronary valve, at the entrance of the coronary sinus; the oval fossa, surrounded by the oval ring (annulus ovalis), on the septum between the two auricles; and the muscular bands on the inside of the auricular appendix, which are called pectinate muscles. The oval fossa is the remains of the oval foramen, which in fœtal life allows blood to pass from the right into the left auricle.

THE RIGHT VENTRICLE.—This cavity has a triangular form, and is continued upwards as a funnel-shaped prolongation leading to the opening into the pulmonary artery. The internal surface of its wall is irregular, on account of the fleshy columns (columnæ carneæ) projecting from it. The openings into the right ventricle are the auriculo-ventricular and the pulmonary artery. The first is guarded by the tricuspid valve, consisting of three leaflets made by reduplications of the endocardium, and which prevents regurgitation of the blood into the auricle during the contraction of the ventricle. There is allowed at this valve, however, a slight amount of regurgitation, in order to protect the lungs from undue engorgement. The free edges of the leaflets are attached to tendinous cords (chordæ tendineæ), which come from the papillary muscles, and prevent the valve being forced upwards into the auricle by the blood current thrust against the closed valve, when the ventricle contracts. The pulmonary orifice is provided with the semilunar valves, which are three crescentic folds that prevent the blood flowing from the artery back into the ventricle. On the free border of each is a nodule (bodies of Arantius), and behind each leaflet is seen a little pouch or pocket called a sinus (sinuses of Valsalva).

THE LEFT AURICLE is similar to the auricle of the other side, as far as shape is concerned, but it has fewer points for examination. Four pulmonary veins open into it and discharge the arterial blood just oxygenated by the lungs. On the wall, between it and the right auricle, is seen a depression corresponding with the oval fossa, described previously when discussing the right side of the heart. The opening into the ventricle is provided with a valve of two leaflets, called the bicuspid, or mitral, valve.

THE LEFT VENTRICLE resembles the right, but has walls three times as thick. It extends downward and projects beyond the right, so as to form the apex or point of the heart. The mitral valve has only two leaflets, but is similar to the tricuspid in attachment and action. The fleshy columns and the tendinous cords of this cavity are the same as on the other side of the heart. The aortic opening, like the pulmonary, has three semi-lunar valves, with bodies of Arantius and sinuses of Valsalva.

STRUCTURE OF THE HEART.—The heart is composed of muscular fibres of the striped variety, although it is eminently an involuntary muscle. It has a fibrous skeleton, as we may call it, consisting of four strong fibrous rings surrounding the auriculo-ventricular and arterial openings; to these are attached the twisted and interlaced fibres which make up its walls. This fibrous framework in some animals is partly composed of actual bone.

POSITION OF THE VALVES.—The actual situation of the valves, in reference to external landmarks, has been determined by thrusting needles into the thorax.

The *mitral* valve lies at the left edge of the sternum in third intercostal space.

The *tricuspid* valve lies a little under the sternum, a few lines below.

The *pulmonary* valve lies at the left edge of the sternum at junction with third cartilage.

The *aortic* valve lies quite near pulmonary, but a little lower.

These are the anatomical positions of the valves, and, as is seen, they all lie so near together that the area can be covered by a silver dollar; hence, in auscultation, as the sounds of the valves are to be differentiated, it is necessary to select points more remote from each other.

The clinical location of the valves is, therefore, as follows:—

The *mitral* valve is to be listened for near the apex beat.

The *tricuspid* valve is to be listened for near the base of ensiform cartilage.

The *pulmonary* valve is to be listened for near left edge of sternum, in second interspace.

The *aortic* valve is to be listened for near right edge of sternum, in second interspace.

THE FŒTAL CIRCULATION.

The peculiarities of the fœtal heart, which are of importance to remember, are: first, the communication between the two auricles by means of the oval foramen in the septum; secondly, the large Eustachian valve, which directs the blood, entering the right auricle from the ascending vena cava, across the auricle and through the oval foramen into the left auricle. The arteries of the fœtus also have two peculiarities: first, there is a communication between the left pulmonary artery and the arch of the aorta by a short vessel called the arterial duct (ductus arteriosus); and secondly, the internal iliac arteries are connected with the mother's placenta by the umbilical or hypogastric arteries. Finally, there are two venous peculiarities: first, the placenta is connected with the liver and portal vein by the umbilical vein; and secondly, the umbilical vein is connected with the ascending vena cava by the venous duct (ductus venosus).

After detailing the characteristics of the fœtal vascular system, we are prepared to discuss the course of the circulation in the child before respiration is established by birth.

Arterial blood is transmitted from the placenta to the fœtus by the umbilical *vein*, which passes through the umbilicus to the liver. Here the branches distribute blood directly to the liver; secondly, mix the arterial blood with the blood in the portal vein and then pass it to the liver; and thirdly, send a small quantity of arterial blood directly into the ascending vena cava by means of the venous duct. The blood sent to the liver reaches the vena cava by the hepatic veins.

In the ascending vena cava the blood, coming from the liver by the venous duct and the hepatic veins, meets venous blood ascending from the lower extremities and abdomen, and mingles with it. This mixed, or arterio-venous, blood ascends in the vena cava to the right auricle, and is directed by the large Eustachian valve across the auricle, and through the oval foramen into the left auricle, where it intermingles with the little venous blood that comes in the pulmonary vein from the lungs. It leaves the left auricle to enter the left ventricle and then passes into the aorta, by which the greater part of it is distributed to the head and arms. The blood sent to the head and arms is thus seen to be anterio-venous in character.

From the head and upper extremities the mixed blood, now even more venous than previously, passes into the descending vena cava and enters the right auricle, where it becomes somewhat mingled with the blood which has come up the ascending vena cava. It then passes downwards into the right ventricle, and thence into the pulmonary artery. The lungs receive very little of this blood, because respiration is not going on; but the major part of it is carried through the arterial duct (ductus arteriosus) into the descending portion of the arch of the aorta. From this point it, now almost entirely venous in character, descends to the abdomen, pelvis and legs, though a large portion of it escapes along the two umbilical *arteries* to the placenta.

After birth the arterial duct, the venous duct and the umbilical vein become obliterated and converted into fibrous cords. The umbilical arteries, as far as the top of the bladder, remain open, carry arterial instead of venous blood, and receive the name of superior vesical arteries; while beyond that point they become fibrous cords. The oval foramen becomes closed, and leaves only a depression, termed the oval fossa.

THE VOCAL AND RESPIRATORY ORGANS.

The larynx, trachea and lungs constitute the vocal and respiratory apparatus. The larynx contains the vocal cords, and is therefore the special organ of voice.

THE LARYNX.

The larynx is a box composed of cartilages, which are joined together by ligaments, moved by muscles, and lined with mucous membrane. The laryngeal cartilages are:—

The thyroid,
The cricoid,
The epiglottis,
Two arytenoid,
Two cartilages of Santorini (or cornicula laryngis)
Two cuneiform.

THE THYROID CARTILAGE consists of two lateral wings, or sides, united to form a projection in front, called the Adam's apple. The posterior angles of each wing are prolonged into superior and inferior horns, the inferior of which articulate with the cricoid cartilage, while the superior are attached to the thyro-hyoid ligament. To the inner surface of the wings, or alæ, where they come together in front, are attached, from above downward, the epiglottis, the false and true vocal cords, the thyro-arytenoid and thyro-epiglottidean muscles. On the external aspect of the wings the attachment of the following muscles occurs:—Thyro-hyoid, Sterno-hyoid, Inferior constrictor of phalanx, Stylo-pharyngeus and Palato-pharyngeus.

THE CRICOID is a cartilage shaped like a seal ring, and placed below the thyroid, with the narrow part in front. There extends between this part and the thyroid the crico-thyroid membrane. On the sides of the cricoid are seen facets for articulation with the lower horns of the thyroid, and on the upper and posterior portion are two articular surfaces for the arytenoid cartilages.

THE ARYTENOID CARTILAGES are pyramidal, with bases articulating with the top of the cricoid behind, and apexes connected with the cartilages of Santorini. The true vocal cords are attached to the anterior angles of their bases; while the false cords are inserted into the anterior surface above the true cords.

THE CARTILAGES OF SANTORINI OR CORNICULA LARYNGIS are small cartilaginous bodies attached to the apexes of the arytenoids.

THE CUNEIFORM CARTILAGES, OR CARTILAGES OF WRISBERG, are pieces of cartilage found in the fold of mucous membrane stretched between the arytenoids and the epiglottis.

THE EPIGLOTTIS is a cartilaginous lid to the larynx, and is shaped like a leaf. It is situated behind the tongue and attached to the inside of the front of the thyroid cartilage. When the larynx ascends during deglutition, the epiglottis is carried downward and backward, so as to close the opening of the larynx, and prevent the food from entering the air passages.

THE LIGAMENTS of the larynx will merely be mentioned, as their names show their location. They are—

- Extrinsic ligaments
  - Thyro-hyoid membrane.
  - Lateral thyro-hyoid ligaments.
- Intrinsic ligaments
  - Crico-thyroid membrane.
  - Capsular ligaments; between cricoid and thyroid, and cricoid and arytenoids.
  - Superior thyro-arytenoid.
  - Inferior thyro-arytenoid (true vocal cords).
  - Hyo-epiglottic.
  - Thyro-epiglottic.

THE INTERIOR OF THE LARYNX.

The cavity of the larynx extends from the superior opening, under the epiglottis, to the lower edge of the cricoid; where the trachea begins. It is divided into two parts by the inferior, or true, vocal cords, stretching across antero-posteriorly. The opening between the cords is narrow, and is called the chink of the glottis (rima glottidis). Above the true vocal cords, or inferior thyro-arytenoid ligaments, are the false vocal cords, which are folds of mucous membrane covering the superior thyro-arytenoid ligaments. The true cords are attached to the base of the arytenoids, and the inside of the angle formed by the sides of the thyroid cartilage. Between the true and false cords is the ventricle of the larynx, the anterior part of which is prolonged upwards and called the pouch of the larynx (sacculus laryngis).

THE MUSCLES, ARTERIES AND NERVES of the larynx have been sufficiently described under the appropriate headings.

THE TRACHEA.

This is a membrano-cartilaginous tube, four and a half inches in length, extending from the larynx to the level of the third dorsal vertebra, where it divides into the right and the left bronchus. It is situated in front of the œsophagus, and is formed of sixteen or twenty rings of cartilage, which, however, are incomplete. The rings are portions of circles, constituting about two-thirds of the circumference of the tube; the remaining posterior third is filled by fibrous membrane, with which the rings are also joined together. The trachea divides into two bronchial tubes, or bronchi, one of which goes to each lung. The bronchi subdivide into small bronchial tubes (bronchioles); and these finally, after becoming by repeated bifurcation smaller and smaller, open into the air vesicles of the lungs. The right bronchus is one inch long, and wider and more horizontal than the left, which is nearly two inches in length. The septum, or partition, dividing the right from the left bronchus, lies to the left of the middle line of the trachea.

Longitudinal and transverse muscular fibres are found in the membrane completing the posterior wall of the trachea.

THE LUNGS AND PLEURAL SACS.

The organs of respiration are the lungs, which are two in number, one situated in each half of the thorax. The right and left lungs, covered by a serous membrane, called pleura, are separated from each other by the heart and other organs in the mediastinal space. Each lung has a concave base resting upon the upper surface of the Diaphragm, and an apex extending underneath the clavicle up into the neck. The outer surface of the lung is convex, and corresponds with the contour of the chest wall; the inner, or median, surface is concave, and presents a fissure, where the root of the lung is to be seen. The root of each lung is formed by the bronchial tube, arteries, veins, nerves and lymphatics, which enter the lung, held together by connective tissue and covered by pleura. Each lung is divided into an upper and a lower lobe by a fissure, which runs obliquely upward and backward in such a manner that the greater portion of the upper lobe belongs to the anterior part of the lung, and the greater part of the lower lobe to the posterior section of the organ. The right lung frequently has a small portion separated from the anterior part of the upper lobe by a secondary fissure. This is called the middle lobe.

Structure.—The lungs are composed of lobules, each of which consists of a ramification of a small bronchial tube with its terminal air cells, of pulmonary and bronchial capillaries, both arterial and venous, and of nerves and lymphatics.

The pleural investment of each one of the lungs is a serous sac, having a parietal layer (costal pleura) and a visceral layer (pulmonary pleura) with a pleural cavity between them. By these layers the inside of the thorac wall and the external surface of the lung are covered by a serous membrane. The pleural membranes of the two sides are distinct from each other, and are shut sacs; the space between the two sacs in the middle line of the body is called the mediastinum. The mediastinal space is divided into the anterior, the middle and the posterior mediastinum.

Let us follow the reflections of the pleura by beginning at the sternum. It passes around the inside of the thoracic wall to the side of the spinal column (costal or parietal layer); from here it passes upon the pericardium and to the root of the lung; then around the convex surface, or outside, of the lung to the front, and bending around the anterior thin edge of the organ, it reaches the front of the root which it covers (visceral or pulmonary layer), and then passes over the pericardium to the sternum. From the back of the root of the lung a fold descends to the Diaphragm, called the broad ligament of the lung. The Diaphragm receives upon its upper surface an investment of the pleura, which is a portion of the parietal layer.

THE MEDIASTINAL SPACE.

The mediastinum is the space left in the middle line of the chest between the two pleural sacs; it extends from the sternum to the vertebral column and is divided into the anterior, middle and posterior portions. It contains all the thoracic viscera except the lungs.

The anterior mediastinum contains:—

1. Muscles (Sterno-hyoid, Sterno-thyroid, Triangular of sternum).
2. Internal mammary vessels.
3. Thymus gland.

The middle mediastinum contains:—

1. Heart and pericardium.
2. Great arteries and veins.
3. Bifurcation of trachea.
4. Phrenic nerves.

The posterior mediastinum contains:—

1. Descending aorta.
2. Œsophagus.
3. Pneumogastric and splanchnic nerves.
4. Azygos veins.
5. Thoracic duct.

THE THYROID AND THYMUS GLANDS.

These glands have no ducts and their function is unknown.

The thyroid is located in front, and at the sides of the upper part of the trachea, and consists of two lobes joined by an isthmus. Its structure is that of an aggregation of small closed vesicles, surrounded by capillary plexuses and held together by connective tissue.

The thymus is an organ of infancy, being fully developed at the age of two years, but becoming atrophied as the child advances to puberty. It lies in the anterior mediastinum behind the sternum, from the level of the fourth costal cartilage to the lower border of the thyroid gland. It has two lateral lobes, consisting of lobules held together by connective tissue. Each lobule contains a small cavity, and all the cavities of each half of the gland open into a large cavity occupying the centre of each lateral lobe. The central cavity contains a white fluid. The gland, however, has no duct.

CHAPTER VIII.

THE URINARY AND GENITAL ORGANS.

THE KIDNEYS.

The urinary organs are the two kidneys, the ureters, bladder and urethra. The kidneys are the glands which secrete the urine, and have each a duct called the ureter, that conveys the urine to the bladder. The bladder is a reservoir in which the urine is retained until discharged through the urethra.

The kidneys lie in the posterior portion of the abdomen behind the peritoneum, and extend from the level of the eleventh rib nearly to the crest of the ilium. Each kidney is one inch thick, two inches wide, and four inches long; and weighs from four to six ounces avoirdupois. The supra-renal capsule, a ductless gland, lies just above the upper end of the kidney. The external border of the kidney is convex, the internal concave and has a notch in it called the hilum. Through this hilum the renal artery, vein, and the ureter communicate with the interior of the organ; the vein is usually the most anterior and the ureter the most posterior of these structures.

STRUCTURE.—If a section of the kidney be made it will be seen that it consists of a solid portion, and a cavity situated at the inner border and communicating with the ureter. This cavity is in fact the dilated, or funnel-shaped, beginning of the ureter or duct of the kidney. This cavity is called the pelvis of the kidney; and is seen to be divided near its circumference into three smaller cavities or pouches, called infundibula (singular, infundibulum). Each infundibulum is subdivided in smaller pouches called cups, or calices (singular, calix). Into these calices open the orifices of the pyramids of the kidney, which show as little openings at the apexes of projections called papillæ.

Looking at the substance of the kidney, we find it to be composed of the outer, or cortical, portion, which is surrounded by a fibrous capsule; and of the inner, or medullary portion, consisting of conical pieces named the pyramids of the kidney. It is the apexes of these pyramids which present the orifices, opening into the calices, of which we have spoken. The cortical is about one-half as wide as the medullary portion, though it, in places, passes between two pyramids down to the pelvis. It consists of convoluted and straight uriniferous tubules, blood vessels, nerves, lymphatics, and small masses, called Malpighian bodies. The medullary portion consists of about a dozen pyramids with their bases towards the circumference of the organ. Each pyramid consists of vessels, looped tubes of Henle, and straight uriniferous tubules converging to discharge the urine at the apex of the pyramid into the calix and infundibulum.

When the kidney structure is examined microscopically the red Malpighian bodies are found to consist of a glomerule of capillary arteries and veins, named a Malpighian tuft, and a membranous envelope called the Malpighian capsule. The Malpighian bodies are found only in the cortical substance, and the capsule is the beginning of a uriferous tubule. The urine-bearing tubules, after leaving the capsule, become convoluted, and then open into a larger straight tube, which continues through the cortical substance and finally passes into the medullary or pyramidal portion and unites with other straight tubes. These at last open upon the papillæ, and discharge the urine into the subdivisions of the pelvis. Some of the tubules, before joining the straight tube, send long loops downwards into the medullary portion, and then open into the straight tubes, as usual.

THE URETER proper extends from the pelvis of the kidney to the base of the bladder, and is a tube about eighteen inches long and as large as a goose quill. It has a fibrous, a muscular and a mucous coat; and is continuous in structure and function with the pelvis of the kidney. It enters the bladder obliquely, so that the portion within the bladder wall is nearly an inch long. By this arrangement the bladder when distended compresses the orifice, and prevents any urine being forced backwards into the ureter.

THE SUPRA-RENAL CAPSULE.

One of these glands, as they are called, lies in front of the top of each kidney, and they are, therefore, described at this time, though having nothing to do with the urinary secretion. They have no duct, are yellowish in color, weigh one or two drachms, and are one or two inches long. They are composed of a yellowish cortical portion, which is, of course, the external, and a pulpy, dark brown medullary portion.

THE BLADDER.

The reservoir into which the urine is discharged by the ureters is called the bladder, which is a muscular bag capable of containing about a pint, when moderately full. It lies in the pelvis behind the pubes and in front of the rectum. In the female it is situated between the pubes and the uterus and vagina. The bladder has four coats: a serous, or peritoneal, which covers only the posterior wall; a muscular, consisting of longitudinal and circular fibres; a cellular, or sub-mucous coat, of connective tissue; and a mucous lining membrane, which has small glands in it, and is covered with epithelium. Around the neck of the bladder the circular muscular fibres are very abundant and form the sphincter muscle of the bladder.

The bladder has a summit or apex, a body, a base, and a neck. The summit is connected with the umbilicus above by the urachus, a cord, the remains of a tubular structure of early fœtal life; and by the obliterated hypogastric arteries which lie at the sides of the urachus. The main portion of the organ is called its body and is covered posteriorly by the peritoneum. Along its sides the ducts of the testicles, coming from the internal inguinal rings, descend to the base of the bladder. The base, or fundus, is the lower posterior part, which lies against the rectum in the male, against the neck of the uterus and the vagina in the female. The ureters pass obliquely through the wall of the bladder near the base. The neck of the bladder is the narrow outlet which is continuous with the urethra, and is in the male surrounded by the prostate gland.

The bladder is held in position by five true ligaments, and five false ligaments, or folds of peritoneum. The following is a description of the true ligaments: The anterior, or pubo-prostatic, are two in number and extend, on each side, from the pubes to the front of the neck of the bladder and prostate gland. The lateral, also two in number, are attached to the sides of the prostate and sides of the base of the bladder. The obliterated urachus, ascending to the umbilicus from the summit of the organ, is also considered a ligament, a superior true ligament. The five false ligaments are formed by folds of peritoneum, and are two posterior, two lateral and one superior. The posterior are between the rectum and back of the bladder, or in the female, between the uterus and bladder; and contain the obliterated hypogastric, or umbilical, arteries and the ureters. The lateral false ligaments extend from the iliac fossa to the side of the bladder, while the single superior one is attached to the top of the bladder and the umbilicus, covering the urachus and obliterated umbilical, or hypogastric, arteries.

The interior of the organ will now require description. It is lined by mucous membrane, which is continuous with that of the urethra and of the ureters and kidneys. Its epithelium is an intermediate form between the columnar and the squamous varieties. Behind the opening into the urethra there is a smooth surface of triangular shape, having the urethra at the anterior angle, the orifices of the ureters at the other angles. The space is called the vesical trigone. At its apex there is a little elevation produced by the prostate, called the uvula of the bladder.

THE URETHRA.

The canal from the bladder to the urinary meatus is called the urethra, and has a length in the male of eight or nine inches, in the female of an inch and a half. The female urethra is of simple construction, but that of the male requires a detailed description. When the pelvis is erect, the male urethra presents one curve, which is in the posterior portion and has its concavity looking upwards. During the ordinary dependent position of the penis the urethra has an additional anterior curve, with the concavity downwards.

The urethra is divided into the prostatic, membranous and spongy portions, as named from the structures through which it passes. The *prostatic* portion is an inch and a quarter long, and lies within the prostate gland, which it traverses from base to apex, near its upper surface. Upon the floor is seen a longitudinal ridge, the verumontanum, or caput gallinaginis, with a depression on each side (prostatic sinuses), into which the prostatic ducts, for the most part, open. In front of and beneath the verumontanum is another depression, the sinus pocularis, within which are the orifices of the seminal ejaculatory ducts. The *membranous* urethra extends from the prostatic portion to the bulb of the spongy body of the penis, and is the narrowest part of the urethra, except the meatus. It is three-quarters of an inch in length along its roof, but only a half inch long on its floor, because the bulb projects backwards under it. It is about one inch below the arch of the pubes, lies between the anterior and posterior layers of the triangular ligament, and is surrounded by the Compressor muscle of the urethra.

The *spongy* or remaining portion of the urethra is about six inches long and traverses the spongy body of the penis. Within the bulb, and also just behind the external orifice, or meatus, the canal shows dilatations. The anterior one is termed the navicular fossa; the dilated portion in the bulb has the orifices of Cowper's gland opening into it, and it is often called the bulbous urethra. The slit-like opening of the urethra is the urinary meatus and has two lips. The urethra is lined with mucous membrane, continuous with that of the bladder and of the outside of the glans, or head, of the penis. It has numerous mucous glands; the large orifice of one of these, situated on the roof of the urethra about an inch and a half from the orifice, is called the lacuna magna. The wall of the posterior portions of the canal is supplied with muscular and erectile tissue.

THE MALE GENITAL ORGANS.

THE PROSTATE GLAND AND COWPER'S GLANDS.

The prostate is composed of glandular tissue and muscular fibres; the former consists of small follicles, secreting a milky fluid and opening into the prostatic sinuses of the urethra; the latter are circular and pass around the urethra. The prostate surrounds the neck of the bladder, or rather may be said to lie in front of the neck of the bladder and to surround the first part of the urethra. It is pyramidal in shape, with the apex directed forwards, and is pierced antero-posteriorly, near its upper surface, by the urethra. It is an inch and a half wide at the base and one inch long, and consists of two lateral lobes, with sometimes a central, or middle lobe. Cowper's glands are two small bodies lying between the two layers of the triangular ligament, and having ducts opening into that part of the spongy urethra which is often called the bulbous urethra.

THE PENIS.

This organ has a root, glans or head, and body. The root is attached to the descending portions (rami) of the pubic bone by the legs (or crura) of the penis, which are the posterior ends of the cavernous bodies of the organ. It is attached also to the symphysis of the pubes by the suspensory ligament. The glans is the free extremity of the penis and is somewhat conical. Its base has a rounded border called the corona, behind which is a groove; while at its apex is the orifice of the urethra, the urinary meatus. The glans is invested by mucous membrane, and has a movable sheath, or covering, cutaneous on the external aspect, but mucous on the inside, to which the name foreskin, or prepuce, has been given. A fold of mucous membrane like a ligament passes from the lower part of the meatus to the prepuce; it is the frenum of the prepuce. The posterior part of the glans and the groove behind are supplied with sebaceous glands, secreting a peculiar cheesy material.

The body of the penis is the portion between the root and the glans; its upper surface is the dorsum. It consists of two parallel cylindrical bodies, the cavernous bodies (corpora cavernosa) forming the upper portion, and the spongy body (corpus spongiosum) lying below in the groove between them. The two cavernous bodies consist of fibrous and erectile tissue, arranged so as to leave numerous meshes or openings in the interior; the bodies are separated from each by the pectiniform septum, and are attached posteriorly to the pubes, by their continuations, the crura, and by the suspensory ligament. The spongy body (corpus spongiosum) commences as the bulb at the triangular ligament, runs forward in the groove beneath the two cavernous bodies, and finally expands into the glans, or head, of the penis, which covers the ends of the cavernous bodies. It is perforated by the urethra. The bulb is covered by the Accelerator of the urine muscle. The spongy body is somewhat similar in structure to the cavernous, being composed of fibrous and erectile tissue. The erectile tissue is made up of innumerable venous plexuses.

THE TESTICLES, SCROTUM, AND SEMINAL VESICLES.

The testicles are the organs which secrete the seminal fluid, and are suspended in a bag, or pouch, called the scrotum. The testicle hangs from the spermatic cord, which contains the vessels, lymphatics and nerves of the testicle, and the duct carrying the semen from the organ. During the early part of fœtal life the testicles are developed in the lumbar region behind the peritoneum, in front of and below the kidneys; but during the last three months of intra-uterine life they descend into the scrotum, by passing through the abdominal wall by means of the inguinal canal. The testicle is guided, or pulled, in this direction by a cord, attached to the testicle and the bottom of the scrotum, called gubernaculum testis. The structures going to, and coming from the testicle, held together by connective tissue, remain in this canal as the spermatic cord, which extends from the internal abdominal ring to the back of the testicle. At this ring the components of the cord separate, for the arteries and veins go to be connected with the abdominal vessels, and the seminal duct (vas deferens) descends into the pelvis to the back of the bladder. The arteries of the cord are the spermatic, cremasteric, and artery of the vas deferens. The inguinal canal is an oblique opening in the abdominal wall, through which the cord passes. Its external opening, or ring, is in the tendon of the External oblique muscle, just above the crest of the pubes, while the internal is in the transversalis fascia, under the arching fibres of the Transversalis, about half an inch above the middle of Poupart's ligament. The outer ring is closed by the intercolumnar fascia, the inner by the funnel-shaped process of the transversalis fascia (infundibuliform fascia).

The scrotum is a pouch, divided by a median septum into two sacs, each containing a testicle and the lower end of the spermatic cord. It is composed of skin and the dartos, which is a variety of superficial fascia containing involuntary muscular fibre. The median line seen on the exterior is the raphé. The left testicle and the corresponding side of the scrotum hang lower than the right.

The testicle is a gland, made up of the body and the epididymis; of which the latter is posterior, and has the spermatic cord attached to its lower extremity. The coverings of the organ are: the vaginal, or serous, tunic, derived from the peritoneum during the descent of the testicle, which has a parietal and visceral layer and covers the front and sides of the gland; the albugineous, or fibrous, tunic, which gives shape and firmness to the organ, and sends in processes to form a vertical septum and smaller partitions between the various lobules of the gland; and finally the vascular tissue carrying the blood vessels.

The minute structure of the testicles consists of the secreting portion, or lobules, and the semen-carrying ducts. The lobules number three or four hundred, consisting of convoluted semeniferous ducts, and discharge the semen into straight ducts (vasa recta); these near the back of the body of the testis anastomose, forming a network of tubules (rete testis). At the upper and posterior corner of the body the rete testis terminates in twenty efferent tubes, or ducts, which pierce the albugineous tunic and empty into the larger globe (globus major) of the epididymis, which is formed of an intricate interlacing of these ducts. These finally empty in a tube, about twenty feet long, which is tightly twisted upon itself to form the body and the inferior lesser globe (globus minor) of the epididymis. From this lower point the tube is continued as the vas deferens, or excretory duct of the testicle, which passes up the back part of the spermatic cord, and enters the abdomen by the inguinal canal. After reaching the internal inguinal, or abdominal, ring, it descends into the pelvis, passes along the side and back of the bladder to its base, where it becomes dilated, and then, having united with the duct of the seminal vesicle, forms the ejaculatory, or common seminal, duct. The vas deferens is a tube two feet long, having a thick wall, a small calibre, and a cellular, a muscular and a mucous coat.

THE SEMINAL VESICLES.

These are two reservoirs, 2½ inches long, each formed from an irregularly dilated and convoluted tube. They lie behind and under the base of the bladder, with their anterior extremities converging towards the ducts of the testicles (vasa deferentia), which lie between the seminal vesicles. The duct of each vesicle unites, at the base of the prostate, with the duct of the corresponding testicle, to form the ejaculatory duct, which is three-fourths of an inch long, and opens into the urethra in front of the verumontanum at the sinus pocularis.

THE FEMALE GENITAL ORGANS.

The external genitals, or vulva, of the female consist of the mons Veneris, the greater lips (labia majora; singular, labium majus), the lesser lips (labia minora; singular, labium minus), the clitoris, the urinary meatus and the opening of the vagina. The internal organs are the vagina, and uterus with its appendages. The mons Veneris is the cushion of fat covering the pubes and supplied with hair; the greater lips are two muco-cutaneous elevations extending from the mons to the perineum, where they have a transverse fold between them, the fourchette, behind which is a depression called the navicular fossa. The lesser lips (labia minora or nymphæ) are two folds of mucous membrane, which extend from the clitoris downwards to become merged into the labia majora. The upper extremities of the lesser lips form the prepuce and frenum of the clitoris. The clitoris is erectile and analogous to the penis, having two cavernous bodies and a glans. The posterior portion of the cavernous body on each side is attached to the ramus of the pubes and of the ischium, and is covered by the Erector muscle of the clitoris. Between the clitoris and vaginal opening is a space, called the vestibule, within which the urinary meatus is seen. It is one inch below the clitoris. The female urethra perforates the triangular ligament as in the male, but is only an inch and a half long, and is very distensible. Below the meatus is the large oval aperture of the vagina, often partly closed by the semilunar hymen, a mere fold of mucous membrane. Instead of the hymen a few granular elevations may at times be found; these are the myrtiform caruncles. On each side of the lower end of the vagina is a gland, analogous to Cowper's gland in the male, termed the vulvo-vaginal, or Bartholine's, gland.

The internal organs are the vagina, and the uterus with its appendages. The vagina is a canal leading from the vulva to the neck of the uterus, and lies between the bladder and rectum. It is a curved tube; its anterior wall measures four, and the posterior five or six inches in length. It is attached around the end of the uterine neck, with the posterior wall extending higher on the uterus than the anterior. Its walls are made up of an external or muscular coat, an erectile and a mucous coat. Between the upper vagina and the rectum there is a pouch of peritoneum, called Douglas's cul-de-sac. The mucous membrane presents many transverse ridges, called rugæ, and the lower end of the tube is surrounded by the Sphincter muscle, analogous to the Accelerator of the urine in the male.

THE UTERUS AND ITS APPENDAGES.

The womb, or uterus, is the organ in which the fœtus is developed, and by which it is finally expelled at the completion of gestation. It lies in the pelvis above the vagina, between the bladder and rectum, with its axis directed towards the umbilicus. It is rudely triangular, and resembles in shape a flattened pear; its dimensions are as follows: thickness one, breadth two, length three, inches. The upper, broad portion is the fundus; the lower, constricted part the neck, and the remainder is the body. To the upper lateral corners are attached the Fallopian tubes, with the round ligaments in front and the ovarian ligaments behind. The lower angle, or neck, of the uterus projects partly into the vagina, and has at its extremity the mouth of the uterus (os uteri), the external orifice of the uterine cavity. The cavity of the uterus is triangular in shape, with its superior angles opening into the Fallopian tubes, and the inferior (cervix) at the external mouth, spoken of above. Where the body and cervix unite there is a constriction of the cavity called the internal mouth (os internum). The uterus has a serous coat, covering all but the lower anterior portion of the organ, a thick and powerful muscular coat of unstriped fibres, and a mucous lining or coat. It is held in position by ligaments and by the vagina, which allow, however, considerable latitude of motion. The ligaments formed by peritoneum are the two anterior or vesico-uterine, two posterior or recto-uterine, and two lateral or broad, extending from uterus to sides of pelvic cavity. The two round ligaments are not formed of peritoneum, but are cords coming from the upper angles of the womb, to pass through the inguinal canals and become lost in the labia majora. Into the canal there passes a tubular process of peritoneum, called the canal of Nuck. The arteries of the uterus are the uterine and the ovarian; the veins are large, and in the gravid uterus are called sinuses.

THE FALLOPIAN TUBES, or oviducts, are two tubes four inches long, placed in the upper margin of the broad ligaments, and attached to the uterus at the upper angles in such a way as to communicate with the two upper angles of the uterine cavity. The opening into the uterus is the ostium internum, and is narrow; the other orifice, or ostium abdominale, is trumpet shaped and opens into the peritoneal cavity. This is called the fimbriated extremity, because it has a number of fringe-like processes. This fimbriated extremity, at the periods of ovulation, attaches itself to the ovary, so that the ovule is passed along the tube into the uterus. The Fallopian tubes have serous, muscular and mucous coats.

THE OVARIES, two in number, are of an almond shape, and placed in the posterior part of the broad ligament. They are attached to the upper angles of the womb by the two ovarian ligaments. The ovary, except in front, is covered by the peritoneum, beneath which is the albugineous tunic enclosing the soft fibrous tissue, or stroma. In the meshes of the stroma are the Graafian vesicles, which at the time of menstruation burst and discharge the ovule into the opening of the Fallopian tube.

THE MAMMARY GLANDS.

The breasts, or mammary glands (mammæ), are the organs secreting milk for the nourishment of the newly-born child. They exist as rudimentary organs also in the male. The space between the third and sixth ribs and from the sternum to the lateral aspect of the chest is occupied on each side by an elevation, the mammary gland of that side. The gland is external to the Greater pectoral muscle, from which it is separated by the deep layer of superficial fascia. Upon its summit is a conical eminence, covered by skin resembling mucous membrane, surrounded by an area of pinkish or dark-colored skin. This is the nipple (mammilla), encircled by the areola. The orifices of the milk ducts are seen on the surface of the nipple. The gland is composed of lobes, formed from lobules; and the lobules consist of vesicles opening into small lactiferous ducts. These, by coalescence, form larger ducts, until about twenty main ducts are finally obtained. These converge towards the nipple, under which dilatations to act as reservoirs occur, and then the ducts open upon the surface of the nipple. The milk ducts are lined by mucous membrane.

CHAPTER IX.

THE ORGANS OF SENSE.

The five senses are: 1, touch, located in the skin; 2, taste, belonging to the tongue; 3, smell, pertaining to the nose; 4, sight, which is the special function of the eye; and 5, hearing, belonging to the ear.

THE SKIN.

The skin, in addition to being the organ of the tactile sense, or touch, is an absorbing and excretory organ, and also serves as a protection to underlying structures. It is composed of two layers, the true skin, cutis vera, or derma, and an overlying layer, called the cuticle, or epidermis. The true skin, or derma, is tough and flexible, consisting principally of white fibrous tissue with some yellow elastic tissue; and is divided into the corium, or lower part, and the papillæ. The corium may be regarded as the groundwork of the skin, and varies in thickness in different localities. The papillæ are small, sensitive and vascular elevations on the upper surface of the corium, and are the organs of touch. They are $\frac{1}{100}$th of an inch high and contain vessels and nerve terminations; the nerves may, in very sensitive regions, have tactile corpuscles, Pacinian bodies, etc., connected with them in the papillary layer. The epidermis, or cuticle, is epithelial in structure and lies upon the derma, with little processes fitting into the crevices between the papillæ. Its lower and softer layers are called the rete mucosum, and contain most of the cutaneous pigment found in the African and other dark races. The upper layers are hard, and may even become horny, as upon the soles and palms.

The skin has appendages for the purposes of secretion and protection, which must be mentioned; they are the nails, hair, sweat and sebaceous glands.

THE NAILS are horny structures on the back of the toes and finger tips, with a root, fitting into a groove in the skin, a body, and a free edge. The nail is a sort of modified epidermis, and has beneath it the cutis forming a matrix, from which the nail is developed. The papillæ under the body of the nail near the root are less vascular than further forward; hence a whitish crescent is seen through the transparent nail at the base. This is the lunula.

THE HAIRS are also modifications of epidermis, consisting of a root seated in the skin, a shaft and a point. The root is a bulbous extremity placed in a follicle of the skin, lined with epidermis. The follicle may extend into the tissue beneath the skin. The shaft has often a dark portion in the centre, called the medulla, and always a fibrous body with a cortex, or external covering.

SEBACEOUS GLANDS.—These are small glands, very abundant in the scalp and face, and around the anus, nose and ear, but absent in the palms and soles. They open by ducts into the hair follicles, or on the surface. The Meibomian glands of the eyelids are very large sebaceous glands.

SWEAT GLANDS.—The sudoriferous glands secrete the sweat, by which a large portion of the deleterious ingredients of the blood is thrown out of the body. They are usually situated in the subcutaneous areolar tissue, and are small reddish bodies, consisting of twisted tubules. The duct of a sweat gland ascends to the surface through the skin, being at first tortuous and then becoming straight. Some of them become rather tortuous again just before opening on the surface.

THE TONGUE.

The tongue is the organ of taste and lies in the floor of the mouth. It has a base or root, a body, and a point or tip. Its root is attached to the hyoid bone by numerous muscles, to the epiglottis by three folds of mucous membrane (glosso-epiglottic ligaments), and to the palate and pharynx by the pillars of the fauces. The inferior surface is fastened to the inside of the lower jaw at the symphysis by the Genio-hyo-glossus muscles, and by the mucous membrane forming the frenum. The tongue is composed of muscles, covered by mucous membrane which presents a median raphé on the top of the organ. This membrane consists, like skin, of a cutis with papillæ and an epithelial layer on top. There are three varieties of these papillæ: 1, the circumvallate or largest; 2, the fungiform; 3, the filiform or smallest. The circumvallate papillæ are about ten in number, and are arranged at the back of the dorsal surface of the tongue, like a letter V with the apex directed backwards; at the point of the V there is a depression called the foramen cæcum. The fungiform papillæ are scattered over the organ, but are especially seen at the tip and sides. They are deep red in color. The filiform are very small and numerous, and at the back are placed in lines parallel to the circumvallate papillæ, but near the tip become more irregular in their arrangement. In the circumvallate, and in some of the fungiform, papillæ flask-shaped bodies, called taste corpuscles, have been described. The surface of the tongue is supplied with mucous glands and scaly epithelium.

THE NOSE.

The organ of the sense of smell is the nose, consisting of the external prominence, known as the nose proper, and the two nasal fossæ, or cavities, separated by a median wall, the septum. The root of the nose is attached to the forehead; the base is attached to the upper lip, and presents two openings, the nostrils, separated by the lower end of the septum, called here the columna. The movable external sides of the nostrils are called the wings (alæ) of the nose. The two sides of the nose form on top the dorsum, or bridge, while the point is denominated the lobe.

The nose proper, that is, the external portion, is formed of bones and cartilages, connected by cellular tissue, covered by skin externally, and lined by mucous membrane. The bones are the nasal and the nasal processes of the superior maxillary; the cartilages are five, two upper lateral, two lower lateral, and the cartilage of the septum. There are usually several small sesamoid cartilages between the lower lateral cartilage of each side and the nasal process of the corresponding upper maxillary. The cartilage of the septum lies in the middle line, below and behind the nasal bones and lateral cartilages, and fits into the notch between the perpendicular plate of the ethmoid and the vomer and palate processes of the upper jaw. It frequently deviates a little to the side, instead of lying exactly in the median line. The small muscles of the nose have already been described in the chapter on Muscles. They produce very little motion of the cartilages of the human nose.

NASAL FOSSÆ.—These two cavities open in front at the anterior nostrils (nares), and communicate behind with the pharynx by the posterior nostrils. They are lined by a mucous membrane, called the pituitary or Schneiderian membrane, which is so thick that the orifices opening into the nasal fossæ are greatly diminished in calibre. It is continuous with the mucous membrane lining the pharynx, middle ear, and eye. The meatuses and the boundaries of the nasal fossæ have been described under the bones of the head.

THE EYE.

The eye is the organ of vision, and is contained in a conical cavity called the orbit. It is spherical in shape, with a segment of a smaller sphere placed in front. The optic nerve enters the back of the eyeball a little to the inner side. The eye consists of three coats, containing refracting media called humors. The three coats are:—

1. Sclerotic and cornea.
2. Choroid, iris, ciliary muscle and processes.
3. Retina.

The humors are:—

1. Aqueous.
2. Crystalline lens and capsule.
3. Vitreous.

The sclerotic is a strong, white, fibrous coat, which gives shape and protection to the eyeball; to it are attached the muscles which move the eye. The inner surface of the sclerotic is brown in color and attached to the outside of the choroid by a layer of connective tissue, called the lamina fusca. Through the posterior portion of this coat, a little to the nasal side, the fibres of the optic nerve enter, giving at the point of entrance a sieve-like appearance. This sieve-like fascia is called the lamina cribrosa, and has at its centre an opening larger than the rest, called the porus opticus, which transmits the central artery of the retina. In front the sclerotic overlaps the cornea, with which it is continuous.

The cornea is transparent and occupies the front of the ball, projecting like a watch crystal set in the case of a watch. The cornea is made up of five layers. The central layer is of fibrous tissue, in front of which is an elastic layer, covered by mucous membrane (the epithelial layer of the conjunctiva); behind the central layer is a posterior elastic layer, and behind it a serous membrane (of Descemet).

The second coat is formed by the iris and ciliary processes in front, and the choroid behind. The ciliary muscle and ligament are situated at the point where the sclerotic, cornea, choroid, and iris come together.

THE CHOROID is the vascular and pigmented coat of the eye, and terminates at the ciliary ligament by being folded inwards to form the ciliary processes. It has three layers; the external is composed principally of the vorticose veins, the middle layer consists of a plexus of blood vessels and is termed the tunica Ruychiana, the internal or pigmentary layer consists of cells filled with pigment granules. This last layer is believed by some to be a part of the retina. The ciliary processes are arranged around the edge of the lens behind the iris; they are seventy-five in number, and fit into folds of the suspensory ligament of the lens. They are really portions of the middle and internal layers of the choroid, which have been turned inward.

THE IRIS is the colored muscular curtain suspended in the aqueous humor in front of the lens, with an aperture in it called the pupil. Its circumference is attached to the choroid and the ciliary ligaments. Its posterior surface is covered with purplish pigment named the uvea. The iris consists of fibrous tissue, pigment cells and involuntary muscular fibre; some of these fibres are circular, constituting the sphincter of the pupil, while others are radiating fibres and form the dilator of the pupil. In the fœtus a delicate vascular tissue closes the pupil, constituting the pupillary membrane.

CILIARY LIGAMENT AND MUSCLE.—The ciliary ligament is a ring of circular fibres surrounding the iris, and joining the external and middle tunics of the eyeball. Where it connects with the sclerotic, a small channel runs between the two, the circular sinus of the iris. The ciliary muscle surrounds the circumference of the iris near the ligament, is composed of involuntary muscular fibres, and regulates the convexity of the lens during efforts of accommodation.

THE RETINA is the semi-transparent nervous coat upon which images are received, and lies between the choroid and the hyaloid membrane surrounding the vitreous humor. Where it terminates in front, near the ciliary ligament, it has an irregular edge called the serrated border (ora serrata); at its centre posteriorly is the yellow spot (macula lutea), with a depression in its centre, termed the central pit (fovea centralis). A little to the nasal side of the yellow spot is the optic nerve entrance. The retina consists of three layers, which have, however, been sub-divided into many more. They are:—

1. External, or layer of rods and cones (Jacob's membrane).
2. Middle, or granular layer.
3. Internal, or nervous layer.

The external layer is contiguous to the choroid, the middle is composed of granules, the internal is semi-transparent, and consists of expansions of the optic nerve fibrils and of nerve cells. Between the external and middle layers is situated the external limiting membrane, between the internal layer and the hyaloid membrane of the vitreous is the internal limiting membrane.

The central artery and vein of the retina distribute branches over its surface and in its internal or nervous layer. The artery enters, and the vein makes its exit from, the globe by the porus opticus in the middle of the optic nerve entrance.

THE HUMORS OF THE EYE are the aqueous, vitreous, and crystalline lens with its capsule. The aqueous humor, which resembles water in composition, fills the space between the cornea and crystalline lens. This space is divided by the iris into an anterior and posterior chamber. The vitreous humor, or body, enclosed in the hyaloid membrane, is between the retina and lens; it is an albuminous fluid resembling jelly, with a depression in front, in which lies the lens surrounded by its capsule. The crystalline humor, which is a double convex lens, with an enveloping capsule, lies behind the pupil in the concavity in the front of the vitreous body, with the ciliary processes surrounding its margin. The lens is held in position by the capsule, an elastic enveloping membrane, and by the suspensory ligament of the lens. The suspensory ligament joins the anterior edge of the retina with the front of the periphery of the lens, and there remains between this ligament and the hyaloid membrane an opening surrounding the lens, termed the canal of Petit. The lens is a transparent, double convex body, made up of concentric layers with a nucleus in the middle; it also seems to be formed by three triangular segments placed together.

THE ARTERIES of the eyeball are the short ciliary, entering around the optic nerve, and running to the middle layer of choroid and the ciliary processes; the two long ciliary arteries, lying between the sclerotic and choroid, to supply the Ciliary muscle and the circumference of the iris and margin of the pupil; the anterior ciliary branches from the ophthalmic, which enter the ball behind the margin of the cornea, to go to the ciliary processes and both margins of the iris; and finally the central artery of the retina, which has already been described.

THE VEINS are formed from branches in the choroid, and piercing the sclerotic empty into the ophthalmic vein.

THE NERVES of the eyeball are the optic, the long ciliary from the nasal nerve, and the short ciliary from the ciliary ganglion.

THE APPENDAGES OF THE EYE.

The eyebrows are elevations over each orbit, supplied with hairs. The eyelids, two in number, an upper and a lower, are movable curtains, or folds, to protect the front of the eye. The upper lid is the longer and more movable, and has a special muscle to lift it, the Elevator of the upper lid. The external angle where the lids meet is called the external canthus; the internal angle is the inner canthus, but here the lids are separated by a little fossa, termed the lachrymal lake. At the bottom of this lake is an eminence designated the lachrymal caruncle. On the edge of each lid, at the margin of the lake is seen a minute opening (punctum lachrymale), which is the beginning of a lachrymal canal. The eyelid is composed of a tarsal cartilage, covered on the outside by the Orbicular muscle and skin, on the inside by conjunctiva. Between the tarsal cartilage and conjunctiva lie the Meibomian glands, and on the edge of the lids are many short curved hairs, placed in two or three rows, named eyelashes (ciliæ). The conjunctiva is a mucous membrane covering the inside of the lids (palpebral portion), and the front of the sclerotic and cornea (orbital portion). Upon the cornea the conjunctiva is very thin, and scarcely consists of more than an epithelial layer; at the inner canthus it makes a semi-lunar fold (plica semilunaris).

THE LACHRYMAL APPARATUS consists of the gland, canals or canaliculi, sac and nasal duct. The lachrymal gland occupies a depression in the frontal bone at the outer angle of the roof of the orbit, and opens by ducts upon the surface of the conjunctiva in the same region. At the inner canthus the small orifices (puncta lachrymalia), lead into minute tubes or canaliculi, which after making a sharp turn, open into the lachrymal sac. This sac lies in a groove formed by the lachrymal bone and nasal process of the superior maxillary, and is really a dilatation of the upper end of the nasal duct. The duct is a canal three-quarters of an inch long leading through the superior maxillary bone into the inferior meatus of the nose. It will thus be seen that the tears, coming from the gland at the upper and outer angle of the optic commissure, must pass over the surface of the eyeball before being discharged by the canaliculi and duct into the nose.

THE EAR.

The function of hearing resides in the ear, which consists of three parts; the external ear, the middle ear, and the internal ear.

THE EXTERNAL EAR is composed of the auricle, or pinna, and the external auditory meatus. The auricle is an irregular concave piece of cartilage, covered by integument and attached to the meatus. Near the meatus it presents a deep depression called the concha; at its lower extremity is a non-cartilaginous portion, the lobule; the elevated edge or rim of the auricle is the helix, between which and the concha is another ridge called the anti helix; between these two elevations is the fossa of the helix; while at the top of the anti-helix is a small depression, termed the fossa of the anti-helix. Below the opening of the meatus is a deep notch situated between two small prominences; the anterior prominence is the tragus, the posterior one the anti-tragus, and the notch the intertragic fissure (incisura intertragica).

The auricle or pinna is fastened to the skull by an anterior ligament extending to the zygoma, and a posterior one attached to the mastoid process There are also two ligaments holding the cartilage of the auricle together; one from the tragus to the helix, the other from the concha to the anti-tragus.

The muscles of the auricle are of two kinds, those which attach it to the head and those extending from one part of the auricle to the other. The former, which move the auricle, have been described on page 50, the latter are unimportant, but are named as follows:—

Great helicine,
Small helicine,
Tragic,
Anti-tragic,
Transverse,
Oblique.

THE EXTERNAL AUDITORY MEATUS, or auditory canal, is an inch and a quarter in length, is directed forwards and inwards, and extends from the concha to the membrane of the tympanum, being formed by cartilage externally, and by bone at its inner extremity. The cartilaginous portion is half an inch, the bony part three quarters of an inch long. The meatus is lined by thin integument supplied with hairs, and ceruminous glands which secrete the cerumen or earwax.

THE TYMPANUM, or middle ear, is a cavity lined with mucous membrane, situated within the petrous portion of the temporal bone, communicating with the pharynx by the Eustachian tube, and traversed by a chain of ossicles, or small bones. These connect the membrane of the tympanum with the internal ear, and thus transmit vibrations from the membrane to the structures contained in the innermost portion of the organ of hearing. The tympanum is bounded above by a thin plate of bone separating it from the brain cavity; below it is separated from the jugular fossa by a bony layer; externally its wall is the membrane of the tympanum and the circle of bone to which this is attached, while its internal wall is the partition between the middle and internal ears. The posterior wall shows several apertures, the openings of the mastoid cells; while the anterior wall presents two orifices separated by a lamina of bone. The upper opening is the canal for the tendon of the Tensor of the tympanum muscle, the lower is the Eustachian tube leading down into the throat, while the bony septum is named the cochleariform process.

The outer and inner walls of the tympanic cavity require further description. In the outer wall are seen three openings; first the Glaserian fissure for the Laxator of the tympanum and the graceful process (processus gracilis) of the malleus; secondly, the posterior opening for the chorda tympani nerve coming from the seventh nerve (facial) in the aqueduct of Fallopius; and thirdly, the anterior opening for the exit of the chorda tympani, leaving the tympanum to go to the canal of Huguier.

The membrane of the tympanum (membrana tympani), forming part of the outer wall, is a semi-transparent oval membrane, placed obliquely, so that it inclines downwards and inwards, and composed of three layers. The outer layer is tegumentary, like the lining of the meatus, the middle is fibrous and elastic, the internal is mucous and derived from the lining of the tympanum. The handle of the hammer bone (malleus) is attached to the membrane of the tympanum.

The points of importance to be noticed on the inner wall of the tympanum are three elevations and three openings. The former are the ridge caused by the aqueduct of Fallopius, the promontory due to the projection of the cochlea of the internal ear, and the pyramid which contains the Stapedius muscle: the openings are the oval window (fenestra ovalis) leading into the vestibule of the internal ear; the round window (fenestra rotunda), situated below the oval window, opening into the cochlea; and a small orifice at the top of the pyramid, through which the tendon of the Stapedius passes. The oval window is closed by the base of the stirrup bone (stapes) and a delicate membrane; the round window is occupied by a membrane often called the secondary membrane of the tympanum. This membrane is fibrous with a mucous surface towards the tympanum, a serous surface towards the external ear or labyrinth.

OSSICLES OF THE TYMPANUM.—The small bones of the ear crossing the tympanic cavity are three in number, and connect the membrane of the tympanum with the membrane closing the oval window. They are called malleus, or hammer, incus or anvil, and stapes, or stirrup. The hammer is attached by the handle (manubrium) to the inner surface of the membrane of the tympanum, and its head articulates with the body of the anvil, or incus. It consists of a head, neck, and three processes, called respectively the handle, graceful process, and short process. The graceful process, situated at right angles to the handle, gives attachment to the Laxator of the tympanum, and passes into the Glaserian fissure; the short process lies at the base of the handle, close to the membrane, and has inserted into it the Tensor of the tympanum.

The anvil resembles a bicuspid tooth with two roots. The hammer articulates with the body of the anvil, where the crown of the tooth would be; the fangs of the tooth are the short and long processes of the anvil, the latter of which terminates in a little nodule, often called the orbicular bone (os orbiculare), which articulates with the head of the stirrup.

THE STIRRUP is an appropriate name for the third bone, which has a head articulating with the anvil, a neck for the insertion of the Stapedius muscle, and two branches joined by the base, or foot piece of the stirrup, which closes the oval window.

LIGAMENTS AND MUSCLES OF THE OSSICLES.—These little bones are held together, so as to be movable, by capsular ligaments; and are attached to the walls of the tympanum by the suspensory ligament of the hammer, suspensory ligament of the anvil, posterior ligament of the anvil, and annular ligament of the stirrup which fastens the foot piece of this bone to the circumference of the oval window. The muscles moving the ossicles of the ear are:—

Tensor of tympanum, from lower surface of petrous bone to short process of hammer, to make membrane tense. It enters tympanum by canal above Eustachian tube.

Laxator of tympanum, from spinous process of sphenoid to neck of hammer, to relax the membrane. It enters by Glaserian fissure.

Stapedius, from interior of pyramid to neck of stirrup; it probably compresses the fluid in the vestibule.

All the structures within the tympanum as well as its walls are covered by mucous membrane, which is continuous with that of the throat, through the Eustachian tube, and also with that lining the mastoid cells.

THE INTERNAL EAR or labyrinth is the portion of the organ of hearing to which the fibrils of the auditory nerve are distributed; while the external and middle portions of the ear are simply the conducting apparatus, which brings the vibrations of sound to the sensitive nerve filaments spread out upon the surface of the inner ear. The internal ear is divisible into the vestibule, semicircular canals and cochlea, which are irregular cavities within the substance of the petrous bone. Within these cavities lies a membranous sac, corresponding in shape with the bony vestibule, semicircular canals and cochlea, named the membranous labyrinth. Between the membranous and long labyrinths is a serous fluid called perilymph, and within the membranous labyrinth is a similar fluid, the endolymph.

The vestibule connects the canals and cochlea and communicates with the tympanum or middle ear. It lies internal to the tympanum and between the cochlea and semicircular canals: the cochlea is in front of, and the canals behind it. In the outer wall of the vestibule is the oval window communicating with the tympanum, but closed by the stirrup bone; while upon the surface of the inner wall is seen the orifice of the aqueduct of the vestibule, transmitting a vein from the posterior surface of the petrous bone. In the roof of the vestibule are the five openings of the semicircular canals, and the large passage way of communication with that part of the cochlea called the staircase of the vestibule (scala vestibuli). On the roof and inner wall are numerous small orifices occupied by filaments of the auditory nerve.

The semicircular canals are three channels, each forming two-thirds of a circle, presenting at each end, before opening into the vestibule, a dilatation (ampulla). The superior and posterior canals are vertical, but at right angles to each other; the external one is horizontal.

The cochlea resembles a small shell, being a tube wound spirally around an axis or modiolus. From the base to apex it makes two turns and a half, and its base presents towards the internal auditory meatus, while the apex points outwards and forwards. The canal of the cochlea is divided into two staircases (scalæ) by a partition designated the spiral lamina; at the apex of the cochlea the staircases communicate by an opening called the helicotrema. Through the axis or modiolus nerve filaments pass, to be distributed to the staircases and spiral lamina between them. The lower staircase, named the staircase of the tympanum (scala tympani) communicates by the round window with the cavity of the tympanum, and here is, in fact, its beginning. The upper, or staircase of the vestibule (scala vestibuli), commences at an opening leading into the cavity of the vestibule.

The canal of the cochlea has been described as divided into two staircases by the spiral lamina. This bony lamina, however, does not extend completely across from the modiolus, or axis, to the outer wall of the canal, but from its edge to the wall stretches the basilar membrane (membrana basilaris). From near the base of the spiral lamina another membrane, termed the membrane of Reissner, extends across to the outer wall; and between the basilar membrane and the membrane of Reissner a third membrane stretches across, called the membrane of Corti (membrana tectoria). The space below the osseous spiral lamina and the basilar membrane is the staircase of the tympanum, that above the bony spiral lamina and the membrane of Reissner is the staircase of the vestibule, while the interval between the basilar membrane and Reissner's membrane is the middle staircase (scala media). Along the upper surface of the basilar membrane lies the organ of Corti, consisting of a series of arches and epithelial cells. The organ of Corti is supposed to be the terminal apparatus of hearing, similar to the retina in the eye, and nerve filaments which enter the cochlea probably terminate in the organ of Corti.

The bony labyrinth, or internal ear, is lined by a serous membrane, which secretes the perilymph or fluid of Cotunnius.

The membranous labyrinth is a closed sac resembling the bony labyrinth in a general way, and contains the endolymph. Its vestibular portion lies in the bony vestibule, but is much smaller and consists of two portions, the saccule and the utricle, which appear to have no orifice of communication. In the walls of the utricle and saccule are found calcareous particles called otoliths. The membranous semicircular canals are like the bony canals, but smaller. The membranous portion of the Cochlea is the middle staircase previously described. Upon the surface of the membranous labyrinth the filaments of the auditory nerve are found.

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